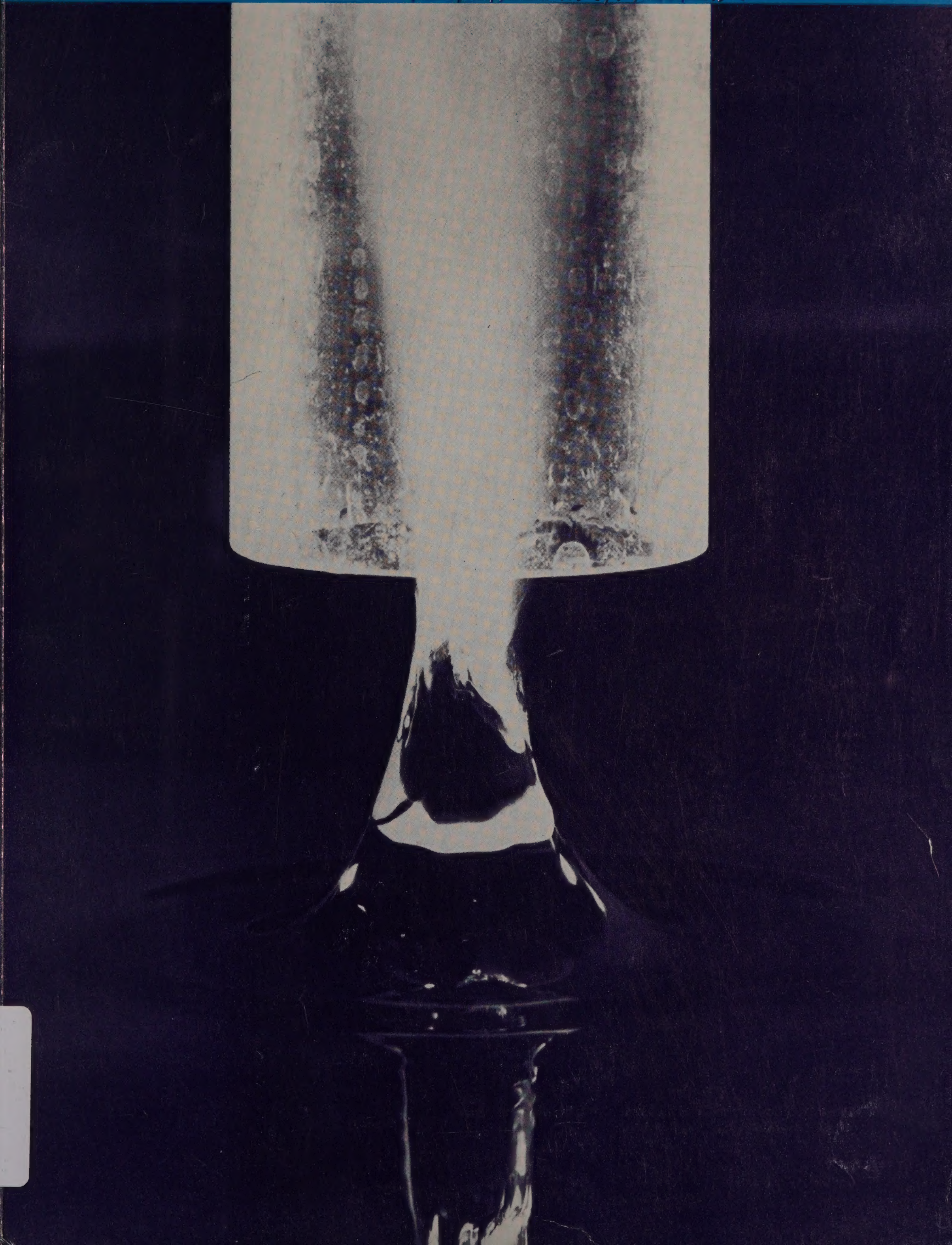
GB COMMITTEE ON

Department of the Environment

Backsiphonage

IN WATER INSTALLATIONS



with an air gap

Department of the Environment

Report of the Committee on Backsiphonage in Water Installations

London Her Majesty's Stationery Office 1974

Designed by HMSO Graphic Design

ISBN 0 11 750845 4

Printed in England for Her Majesty's Stationery Office
by Staples Printers Ltd, Kettering, Northants.

Dd 288312 K24 8/74

Foreword

TO THE RIGHT HON. GEOFFREY RIPPON QC MP SECRETARY OF STATE FOR THE ENVIRONMENT

Sir

We have the honour to submit our report in which we investigate the problem of backsiphonage and advise on reasonable precautions.

We have defined backsiphonage to include all types of backflow into pipework whereby water intended for drinking in the home, canteen or elsewhere may become contaminated with water contained in connected appliances. One of the incidents reported to us was a case where the contents of a urinal bowl had been drawn into a coffee making machine.

Under the Water Act 1945, water undertakers have been empowered to make byelaws regulating water installations and connected appliances and a large number of these byelaws are directed against such contamination.

We have arranged for surveys to be carried out and have reviewed the present precautions against backsiphonage. In some instances we recommend that further measures be taken, in others we have suggested relaxation.

From the outset we have found a marked need to rationalise rather than a need to be, on average, less or more stringent. Our recommendations have been directed to this end.

In the home we have found that, by and large, existing precautions are satisfactory except that insufficient attention has been paid to the risks arising out of the use of hoses connected to drinking water taps. Nevertheless, the byelaws governing hot water installations in the United Kingdom are unduly restrictive in that they equate the risk from contamination by hot water with the risks arising, for instance, from contamination by the contents of water closet pans. This has led us to recommend an easing of the restrictions governing the former which will have the important effect of permitting the introduction of pressurised hot water supply installations. In these, water is taken directly from the mains instead of through a feed/storage cistern.

We also recommend that in buildings housing more than one family or in which large numbers of people can make use of a water installation, certain additional precautions should be taken because much higher probabilities of contamination arise.

We deal in separate chapters of the report with the use of water in industry, hospitals, port installations and in agriculture. By and large, we recommend that drinking water installations should be separated from all other water installations and should be readily identifiable. This is no more than better present day practice but it needs spelling out and being made clear in byelaws or in whatever instruments may be used for implementing our recommendations.

The precautions which we recommend consist in part of installation requirements and in part of the inclusion of devices to prevent backsiphonage from points of water use and elsewhere. Installation requirements are dealt with in the body of the report and performance recommendations for devices are included in appendices 1 to 10. Our work, so far, has only covered the smaller sizes of devices, in general up to 40 mm nominal diameter. Further research must be undertaken to cover larger sizes as and when the need arises. These appendices are forerunners of what we hope will become a series of national documents which will enable designers, manufacturers and approved bodies to work to recognised criteria. We recommend that such documents should be incorporated in the appropriate form of legislation.

The four drawings appended to our report show the application of our recommendations to a typical house and a block of flats. Alternatives are given for installations with and without roof storage. There are many ways in which our recommendations could be met and these drawings are intended only for illustrative purposes.

Regulations or byelaws will by themselves achieve nothing and we have in our meetings discussed at length systems of enforcement including inspection, approval of devices and appliances, and quality assurance generally, upon which satisfactory installations will depend. We have noted that in the Water Act 1973 the National Water Council will have the duty of establishing a scheme which will absorb the work of the present Standing Committee on Water Regulations of the BWA. These matters are commented on in the final chapters of the report.

Our work has taken more than four years and has included a wide and varied programme of research. Increasingly, we have found it necessary to refer to work abroad particularly in France, Germany and Holland. We are concerned that the momentum of research work and of communication with those countries is not lost when we are disbanded and look in particular to the NWC scheme to maintain liaison with test institutes abroad.

The number of people and organisations who have submitted evidence and have assisted our work are too numerous to mention individually but it is on these that our work has depended. The result is that we are convinced that our report is soundly based on the main body of experience and knowledge in the United Kingdom and we respectfully commend it to you.

As a final word we wish to pay tribute to our first Chairman, Mr B C Wood, who died in January 1972 after a long illness. He organised the work of the Committee in the crucial early stages and credit for much of what we have done should go to him. We also record our thanks to our Secretaries for the patient and skilful way in which they have smoothed the progress of our work.

S F White *Chairman*
J S W Bath
A D Bostock
P Burberry
D C Cassels
M L Franck
D A Gill
E Haslam
E H Lemay
J Sandor
J W Seddon
C A Serpell
J Thorburn
E Windle Taylor
A F E Wise
C P Woolley

9th October 1973

Contents

		Foreword	
			Page
CHAPTER 1		**Introduction**	
Paragraphs	1.01–1.05	What is backsiphonage?	1
	1.06–1.07	Development of measures to control backsiphonage	1
	1.08	The Tripartite Working Group	2
	1.09–1.10	Consultations	2
	1.11	Application	2
CHAPTER 2		**Present precautions against Backsiphonage**	
	2.01	General	3
	2.02–2.04	Protection of water in the public mains	3
	2.05–2.09	Protection in consumers' installations	3
	2.10–2.13	Overseas practice	5
CHAPTER 3		**Incidence of Backsiphonage and survey of domestic installations**	
	3.01	Investigations	7
	3.02–3.09	Survey of backsiphonage incidents	7
	3.10–3.13	Survey of domestic installations	9
	3.14	Conclusions	10
CHAPTER 4		**Classification of potential Backsiphonage situations**	
	4.01–4.07		11
CHAPTER 5		**Devices designed to prevent the occurrence of Backsiphonage**	
	5.01–5.02	Introduction	13
	5.03–5.05	Reliability of devices	13
	5.06–5.15	Devices without moving parts	14
	5.16–5.19	Devices with moving parts	14
	5.20	Devices used in combination	15
	5.21	Quality assurance	15
	5.22	Installation conditions and acceptance tests	16
	5.23–5.26	Classification of protection afforded by various devices	16
CHAPTER 6		**Principles for protection against Backsiphonage**	
	6.01–6.02	General	17
	6.03–6.04	The future	17
CHAPTER 7		**Protection of water in the home and domestic use elsewhere**	
	7.01–7.03	Protection built into installations and appliances	19
	7.04	Inspection and safety of installations	19
	7.05	Boiler and central heating circuits (heating water)	19
	7.06–7.09	Hot water supply	19
	7.10	Hose union taps and flexible shower hoses	20
	7.11	Bidets	22
	7.12	Cold water storage cisterns	22
	7.13–7.14	Domestic washing machines	22
	7.15	Recommended precautions	22
	7.16	Effect of the recommendations	22

		Page
CHAPTER 8	**Whole installation protection**	
8.01	Principles of application of whole installation protection	23
8.02	Whole installation protection—stored installations	23
8.03–8.04	Whole installation protection—pressurised installations	24
8.05–8.06	Recommendations for requiring whole installation protection	24
CHAPTER 9	**Protection of water used in industry**	
9.01	General	27
9.02	Present position	27
9.03	Recommendations	27
9.04	Effect of recommendations	28
CHAPTER 10	**Protection of water used in hospitals**	
10.01–10.03	General	29
10.04–10.05	New National Health Service Hospitals	29
10.06	Other hospitals and medical establishments	29
10.07–10.14	Recommendations	30
CHAPTER 11	**Protection of water used in ports, docks and harbours**	
11.01	General	31
11.02	Water supplies to ports	31
11.03	Arrangement on board ship	31
11.04	Potential backsiphonage situations	31
11.05	International ship-shore connector	32
11.06	Recommendations	32
11.07	Effect of recommendations	32
CHAPTER 12	**Protection of water used in agriculture**	
12.01	Present position	33
12.02	Need for special precautions	33
12.03–12.04	Recommendations	33
12.05–12.06	Effect of recommendations	34
CHAPTER 13	**Installation cost implications**	
13.01–13.04	General	35
13.05–13.06	Protection at the point of use	35
13.07–13.10	Whole installation protection	35
13.11	Industrial, commercial and agricultural installations	36
13.12–13.13	Hospital installations	36
13.14–13.16	Conclusions	36
CHAPTER 14	**Enforcement**	
14.01–14.02	The present position	37
14.03–14.04	Frequency of inspection by the water undertaker	37
14.05–14.06	Extent of responsibility for enforcement	37
14.07–14.11	Application of the report's recommendations	38
CHAPTER 15	**Continuing work**	
15.01	Testing and evaluation of devices	39
15.02	Assessment of future developments	39
15.03	Type testing and approval	39
15.04	Quality control	39
15.05	Interpretation	39
15.06	The national body	40

		Page
CHAPTER 16	**Summary of main recommendations**	
16.01–16.37		41
	Glossary of terms	45
Appendices 1	Basic requirements of the air gap	48
2	Basic requirements for the pipe interrupter	49
3	Basic requirements for the pipe loop	50
4	Use and installation of devices without moving parts	51
5	The break pressure cistern	52
6	Basic requirements for the check valve	53
7	Basic requirements for the terminal anti-vacuum valve	55
8	Basic requirements for the in-line anti-vacuum valve for a permissible operating pressure up to 10 bar	57
9	Use and installation of devices with moving parts	60
10	Negative pressure (vacuum test) figures	61
	Tables, figures and drawings	
Table 3.1	Analysis of replies to the IWE questionnaire	7
Table 3.2	Type of backsiphonage hazard situation	10
Table 5.1	Classification of backsiphonage prevention devices	13
Table 7.1	Protection against Class 1 risks in domestic installations	21
Table 7.2	Protection against Class 2 risks in domestic installations	21
Table 7.3	Protection against Class 3 risks in domestic installations	21
Table 8.1	Whole installation protection	23
Table 9.1	Protection of water in industrial, trade and commercial installations	28
Table 10.1	Protection of water in hospitals and other medical and dental establishments	30
Table 12.1	Protection of water in agricultural and horticultural premises	34
Figure 1	Air gap with unrestricted overflow	4
Figure 2	Float operated valve fitted in a storage cistern	4
Figure 3	Submerged inlet in relation to the storage cistern	4
Figure 4	Whole installation protection: stored installations	15
Figure 5	Whole installation protection: pressurised installations	25
Drawing A	Large residence with stored installations (except for cold water supply to the kitchen tap)	62
Drawing B	Large residence with fully pressurised hot and cold water installations	64
Drawing C	Multi-storey block of flats with stored installations (except for cold water supplies to kitchen taps)	66
Drawing D	Multi-storey block of flats with fully pressurised hot and cold water installations	68

Membership and Terms of Reference

The Technical Committee on Backsiphonage in Water Installations was appointed by the Minister of Housing & Local Government in April 1969 with the following terms of reference:

'To investigate the problems of backsiphonage in relation to domestic and industrial water supply systems; to seek and assess evidence to determine the risk of occurrence of backsiphonage and the dangers it may involve in the range of circumstances commonly occurring in practice in such systems; and to consider and advise on the precautions it is necessary and reasonable to require to prevent backsiphonage.'

Membership of the Committee from its inception has been as follows:

Mr B C W Wood	(First Chairman—died January 1972)		DOE
Mr S F White	(Second Chairman—member from March 1970)		DOE
Cdr J S W Bath		Nominated by	BWA
Dr A D Bostock		" "	DHSS
Mr P Burberry		" "	RIBA
Mr D C Cassels		" "	DOE
Mr M L Franck	(from October 1970)	" "	DHSS
Mr D A Gill		" "	WRA
Mr E Haslam		" "	BWA
Mr E R Haynes	(to October 1970)	" "	DHSS
Mr T P Hughes	(to October 1970)	" "	DOE
Mr E H Lemay		" "	CBI
Mr R V Lindsley	(to August 1972)	" "	DOE
Mr R Reekie	(to March 1971)	" "	SDD
Mr J Sandor		" "	DTI
Mr J W Seddon		" "	BWA
Mr C A Serpell		" "	IWE
Mr J Thorburn	(from March 1971)	" "	SDD
Dr E Windle Taylor		" "	BWA
Mr A F E Wise		" "	BRE
Mr C P Woolley		" "	PSA
Administrative Secretary: Mr C McFarlane			DOE
Technical Secretaries: Mr C J D Webster			BRE
Mr E F Young			DOE
Asst Technical Secretary: Mr P M Trotman			BRE

Introduction

What is backsiphonage?

1.01. As its name implies, backsiphonage occurs when liquid is siphoned back against the direction of normal flow or pressure. In the case of public water supply, contaminated liquid might enter the mains system from a water consumer's installation and thus create a hazard to health.

1.02. At times of significant reduction in pressure in a public water supply mains system, pressures will also fall in domestic and industrial consumers' supply pipes (which are directly connected to the mains). Pressures in these supply pipes could fall below atmospheric pressure in certain circumstances, as it would also at water fittings and appliances connected thereto. If an outlet were open to the atmosphere, air would be drawn into the service pipe and little harm would ensue. But should the outlet be submerged below the free surface of a contaminated liquid at associated equipment, or so close to the surface of a liquid that suction might result, potentially harmful liquid could be drawn back which would contaminate the consumer's installation. If the fall in pressure in the mains were sustained long enough, contaminated liquid could reach the mains. In certain circumstances, backsiphonage can occur within an installation fed from a storage tank within a consumer's premises.

1.03. Reduced pressures in a public water supply mains system are not uncommon and may be brought about, for instance, when there is heavy draw-off at times of peak demand or when water is being drawn off for fire-fighting purposes or even when there is a serious leak in the mains. There are also times when sections of the mains have to be shut off and emptied for purposes of maintenance or repair. In these circumstances reverse flows may occur. A comparable risk, though not strictly speaking one of backsiphonage, arises from the use of pumps or private supplies on consumers' premises in such a way that water which may be contaminated may enter the public mains. The Committee has also considered the conditions that can arise within a consumer's installation whereby water which may be contaminated can find its way into pipes supplying water for drinking; this latter type of backsiphonage is of particular significance in multi-storey buildings.

1.04. In the general case, three conditions must be satisfied for backsiphonage to occur in an installation:

a. an appliance or fitting must be connected to the installation in such a way that the water outlet is submerged or close to the water surface;
b. the valve or tap controlling flow from the installation to or through the appliance or fitting must be open;
c. the pressure in the pipe connected to the appliance or fitting must fall below the equivalent of that of the free water level at the fitting or appliance.

To be successful in preventing backsiphonage it is necessary at all times to control either conditions at an outlet connected to the installation, or the pressure conditions in the pipework leading to the outlet.

1.05. We have interpreted the term backsiphonage, for purposes of this report, to include all types of backflow whereby water intended for drinking and domestic use, whether in the home, canteen, commercial premises or elsewhere, may become contaminated, either by contact or by mixing, with water which could contain matter potentially hazardous to health or which could give rise to complaint from consumers. We have not concerned ourselves with the advantages or disadvantages claimed for different systems of plumbing. Our concern has been to recommend suitable precautions to prevent backsiphonage from occurring in all plumbing systems. We draw attention to associated matters, such as scalding, noise, safety of pressure vessels and unbalanced pressures, some of which may be affected by our recommendations. For instance, in paragraph 13.05(iii), we note that acceptance of our recommendations would permit the introduction of fully pressurised installations in the United Kingdom, but we do not express an opinion as to the merits of such installations in terms of cost and performance.

Development of measures to control backsiphonage

1.06. The last major examination in the United Kingdom of problems of backsiphonage was at a conference in 1949 organised by the British Standards Institution. Since that time, the progressive amendment of byelaws, codes of practice and standards have strengthened measures to control and prevent backsiphonage. The Department of the Environment issue model byelaws which are concerned with the prevention of contamination of water supplied by water undertakers. These model byelaws have brought about reasonably close uniformity of the byelaws made by water undertakers.

At the present time, precautions against

backsiphonage are almost entirely based on the provision of air gaps which in principle can be, in the opinion of the Committee, most satisfactory devices.

1.07. Nevertheless, the present position in the United Kingdom is not entirely satisfactory for a number of reasons:

a. Byelaws can be, and often are, interpreted differently.
b. Some byelaws permit an "effective" device for use as an alternative to an air gap for the prevention of backsiphonage. However, there is no widely accepted definition of such a device or of its required performance.
c. Because an air gap is, in certain circumstances, the only permitted device, development of plumbing practice, water fittings and appliances has been affected even though risks consequent on the occurrence of backsiphonage may be small.
d. By contrast, there is evidence that present precautions may not be stringent enough in some circumstances.
e. Difficulties have arisen in effectively preventing potential backsiphonage situations from arising in certain circumstances from ships in docks and harbours.

The Tripartite Working Group

1.08. At about the same time as our committee was set up, the United Kingdom under the lead of the Ministry of Technology (now the Department of Trade and Industry) set up with France and Germany a Tripartite Committee to discuss matters of mutual interest in the field of standards and quality assurance, particularly in areas where differing legislative requirements could lead to technical barriers to trade. A Working Group was set up to deal with regulations affecting water using appliances and to make recommendations concerning the harmonisation of subordinate legislation in the three countries. There has been increasing interaction between our work and that of the Group. This study is especially relevant because the United Kingdom is now a member of the European Economic Community. We have taken into account some of the variations between practice in the United Kingdom and abroad, but it should be made clear that our task has been to recommend suitable precautions for all systems of plumbing and not to try to influence United Kingdom practice one way or the other. Our aim has been to maintain the high standard of protection which is afforded in many respects in the United Kingdom at the present time.

Consultations

1.09. Among those likely to be affected by our work are:

a. Statutory water undertakers.
b. Water Users, including domestic, commercial, industrial and agricultural consumers.
c. Manufacturers of fittings and appliances.
d. Design engineers, architects, contractors and installers.

When we had settled the principles upon which we proposed to base our report, we published a Progress Statement (dated April 1971) to inform and to elicit comment. The bodies to whom the statement was circulated included professional associations and institutions, trade and manufacturers' associations, government departments, research bodies, associations of water undertakings, gas and electricity councils and such bodies as the National Farmers' Union and the British Standards Institution. We are most grateful to all those who submitted comments. These have all been taken into account in the formulation of our recommendations.

1.10. For many years the Standing Committee on Water Regulations and later the British Waterworks Association (BWA) have acted on behalf of water undertakers in matters pertaining to byelaws and their enforcement. More recently, they have set up, and progressively improved, an organisation to promote uniformity of interpretation and to examine and test fittings and appliances on behalf of member undertakings. The BWA Standing Committee has achieved a wide measure of agreement between undertakings. On our behalf, the BWA carried out in its laboratory a comprehensive programme of testing of devices on which many of the conclusions given in Chapter 5 are based.

Application

1.11. For convenience, references made in this report to statute and byelaws have been restricted to those in force in England but the report generally, and the recommendations in particular, could be applied equally over the whole of the United Kingdom.

2

Present Precautions against Backsiphonage

General

2.01. Backsiphonage prevention practice has evolved over many years and is based on a wealth of practical experience. This chapter has three parts. The first is a review of practice of water undertakers to protect water in their mains in day to day operation. The second is a review of practice of designers of installations and manufacturers of appliances and fittings, to prevent backsiphonage occurring within consumers' installations. The third part is a brief review of overseas practice, particularly that on the Continent in France and Germany.

Protection of water in the public mains

2.02. Pressures vary in the mains distribution systems of water undertakings according to topography, height and capacity of service reservoirs, size and condition of mains and the location and timing of the demands of consumers. Below atmospheric pressures in mains can occur either when the supply is inadequate to meet the demand on the mains distribution system or when a main is emptied following a burst. As a result, contaminated water may enter the mains either through:

a. a consumer's connection to a main,
b. a defect in a main, or
c. the connection to a main of mobile plant such as defective street cleaning vehicles and gully emptiers.

Contamination through a consumer's connection can be prevented by proper design and it is this aspect of backsiphonage with which this report is mainly concerned.

In contrast with consumers' connections, it is most unlikely that defects in mains will ever be entirely eliminated, but we have received no evidence that backsiphonage as a result of such defects constitutes a major hazard. Such risks that may arise from either defects in mains or the connection of mobile plant to mains may be countered to an appreciable extent by improvements to the distribution system to reduce, as far as possible, the occurrence to low or below atmospheric pressures, and by ensuring that mobile plant is satisfactorily designed to prevent backsiphonage of contaminated water from the plant to the main.

2.03. In many instances, metered supplies are afforded by agreement into storage cisterns equipped at the inlet with air gaps. Sometimes an undertaker provides at his own expense, check (non-return) valves at metered connections. No other forms of backsiphonage prevention device are in common use at such connections.

2.04. Automatic sprinkler installations to extinguish small fires locally, and at the same time to give an automatic warning of the outbreak of fire, are covered in Rules prepared by the Fire Offices' Committee (FOC). A British Waterworks Association (BWA) Sub-Committee studied the FOC Rules (29th edition, 1968) and made representations to the FOC concerning safeguards against contamination of the mains arising from the use of automatic sprinkler installations. The FOC issued an amendment to the Rules (No 12, December 1972) which noted that (i) inter-connections between the mains of an undertaking and another source of water, whether by permanent pipework or, for example, by means of a fire brigade inlet, would not be permitted (ii) non-return valves would not be accepted as adequate safeguards against backflow (iii) any cistern under atmospheric pressure supplying a sprinkler installation should be controlled by a ball-valve discharging above the top level of the cistern and (iv) connections between the town mains and a discharge pipe from such a cistern would be prohibited.

Protection in consumers' installations

2.05. Protection of water in the mains is also effected by preventing backsiphonage from occurring at each point of use within the consumer's installation. The most widely used device for this purpose is the air gap. A general case is illustrated in Fig 1 in which water, leaving a pipe under pressure, passes downwards to its points of use; it crosses an air gap. In the event that pressure in the pipe were to fall below atmospheric pressure, water would not be drawn back up into the pipe providing the distance between the liquid surface and the pipe were large enough at all times. The critical situation for a particular pipe outlet and associated vessel occurs when the vessel overflows and the air gap is a minimum. Should the air gap be less than a particular critical distance which varies with the pipe size, water could be drawn up in combination with air at high velocity. The illustration on the cover of our report is a photograph of backsiphonage occurring under such conditions. Ideally, air alone should enter the pipe. Photographs 1 to 4 illustrate tests carried out at the Building Research Establishment on a 40mm pipe. It will be seen that a clear distance of 70mm is necessary to ensure backflow cannot occur from a

Figure 1
Air gap with unrestricted overflow

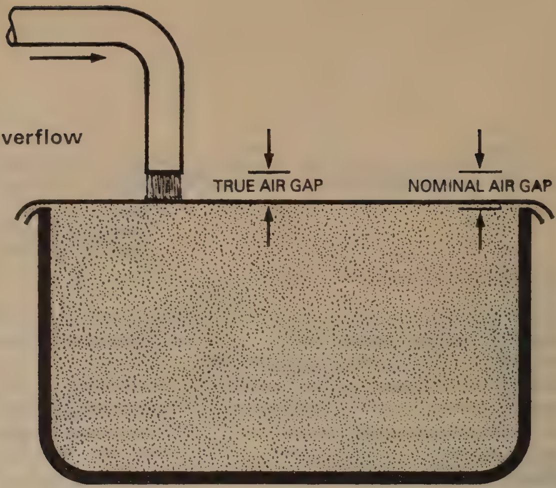


Figure 2
Float operated valve fitted in a storage cistern

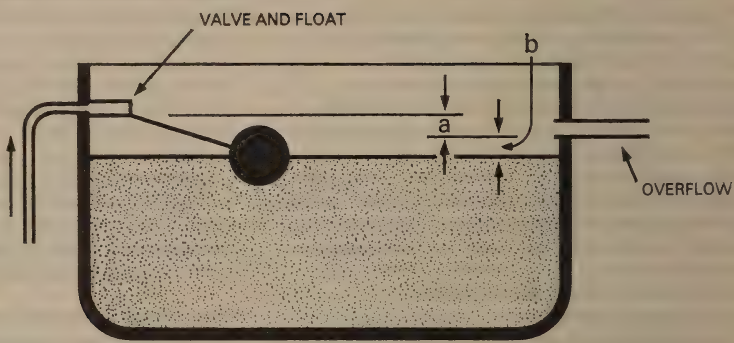
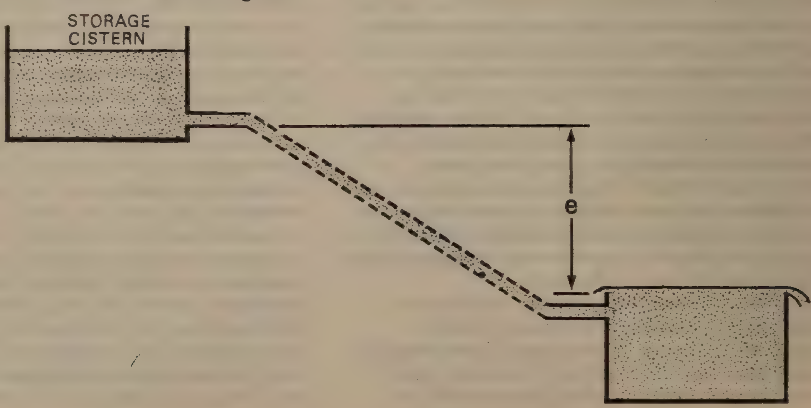


Figure 3
Submerged inlet in relation to the storage cistern



free water surface up to a 40mm pipe.

2.06. The form of air gap illustrated in Fig 1 is one in which overflow from the associated vessel is unrestricted (that is, it is over-rim). The operation of the air gap could not be affected by conditions downstream, for example, by a blocked overflow or the use of a pump. The following are circumstances where it is used:

a. to prevent contamination of a water undertakers' mains arising from certain industrial and research installations;
b. to prevent liquid in baths, wash basins, sinks and similar sanitary appliances flowing back into the installation. Taps are generally fixed so that they cannot discharge at a level lower than ½ inch (12mm) above the lowest part of the top edge of the sanitary appliance;
c. in drinking fountains, where the discharge point is above the basin spillover level;
d. to prevent contamination of a water undertaker's mains arising from a cistern on a consumer's premises receiving water from either a private source or a non-potable source, as well as water from the public mains. Water from the latter is taken into the cistern only through an air gap as in (a) above;
e. to protect water undertakers' mains from contamination arising from backflow at animals' drinking troughs which are supplied direct from a service pipe. The air gap is not less than 1 inch (25mm);
f. where an overflow pipe leading from a WC or a urinal flushing apparatus is arranged to discharge into a pan or urinal.

2.07. Other forms of air gap are used. The most common is that provided in a cistern fitted with a float operated valve (see Fig 2). Inlets are intended to discharge at levels higher than the overflow pipe by not less than the diameter of the pipe (distance a). In cisterns up to 1,000 gal (4546 l), ballvalves and floats should be adjusted after installation so that the highest level the water can reach is not less than 1 inch (25mm) below the overflow (distance b). The resulting air gap (that is, the space between the inlet and the water level measured vertically), is intended never to be less than 1¾ inches (45mm). However, the BS1125 flushing cistern when used in conjunction with a BS 1212 Part 1 ballvalve does not necessarily provide a satisfactory air gap between the discharge from the ballvalve and the warning pipe. In cisterns over 1,000 gal (4546 l) capacity, the resulting air gap is intended never to be less than 3 inches (75mm). A common feature is that the effectiveness of the air gap can be adversely affected by conditions downstream, for example, by blocked overflows or reverse flow on pump stoppage.

Silencing pipes are widely used, not only in WC flushing cisterns but also in cold water storage cisterns. Where these attachments are installed, the air gap, as a form of protection against backsiphonage, is effectively destroyed (see also paragraph 3.03).

2.08. A form of air gap often used where inlets to appliances are installed below overflowing levels is shown at Fig. 3. In this case, the feed pipe to the appliance draws water from a storage cistern (or cylinder with a vent); the connection is made to the cistern at a level which is not less than 1 inch (25mm) above the over-rim level at the appliance. The connecting pipe would have connected to it no other fitting which discharged at a level lower than the appliance over-rim level unless additional protective measures were provided.

2.09. In addition to the air gap, a number of other measures or devices are used to prevent backsiphonage including:

a. complete separation of systems, for example, the separation of cold water from hot water installations which has led to the double outlet type combination tap assembly;
b. non-return and air break valves to prevent backflow from domestic water softeners; loose jumpers in cold water taps can also act as backflow preventers;
c. air inlet valves in the fixed end connections of hand-operated hosepipes and shower fittings (the free end may be left lying in contaminated water in associated sanitary apparatus);
d. soft suction hoses connecting hydrants to fire engines (a sub-atmospheric pressure occurring in the main, or at the fire engine pump, causes the hose to collapse);
e. in some hot water systems, air venting devices are fitted where open ended pipes cannot be provided at high points;
f. some types of domestic washing machine have alternative forms of air gap on the water inlet;
g. the pipe interrupter fitted in certain types of domestic washing machines (for description see paragraph 5.11).

Overseas Practice

2.10. We have taken note of foreign practice. Plumbing practice varies from country to country, but on the Continent domestic installations incorporating cold water storage cisterns are the exception rather than the rule. In such fully pressurised installations, it is possible to use the air gap only at the point of use. In some countries, precautions specified against backsiphonage are stringent but this is not universal. In general, the air gap is a widely used device.

2.11. We have studied practice common in parts of Western Germany in which protection of water undertakers' mains from contamination arising in consumers' fully pressurised installations is effected by (a) the use of an air gap wherever possible at each point of use and (b) the provision, in combination, of anti-vacuum valves (at high points), and check valves (in each service pipe near the mains connection) with upstands built-in at various locations in the installation pipework. Pipe interrupters are much more common than in this country.

2.12. In Western Germany, cold water storage cisterns are not normally permitted in dwellings. Where an indirect heating system is used, the make up water needed for the primary circuit is fed in either from a combined feed and expansion water cistern fitted with an air gap or it is fed in at

intervals under manual control by means of a temporary hose connection from the supply pipe to the primary circuit. In the secondary circuit, backflow of hot water into the supply pipe is prevented by means of a check valve. In the USA, however, the use of a check valve in these circumstances is forbidden on safety grounds (to avoid explosion risks). In Germany, cross-connections between primary and secondary circuits are prohibited and no water may be drawn for use from a primary circuit.

2.13. In France, similar precautions are taken although in some areas cold water cisterns are still permitted. Tap outlets are usually several centimetres above the basin spill-over level. Rim-fed bidets with hand sprays are not permitted.

In Holland, precautions vary between undertakings. In some cases, two check valves are installed in series on each service pipe. In Belgium, regulations govern backsiphonage precautions and include the requirement of air gaps at flushing cisterns, taps and bidets. Check valves are required at calorifiers and, as in Germany, the connection of central heating systems directly to the mains water supply is prohibited.

On the Continent, flushing valves are commonly used. The approved protection afforded to WC pans in such cases is usually the pipe interrupter.

3

Incidence of Backsiphonage and survey of domestic installations

Investigations

3.01. We have carried out two investigations:

(a) a survey of backsiphonage incidents, undertaken at our request by the Institution of Water Engineers (IWE) and

(b) a survey of domestic installations, undertaken on our behalf by the Water Research Association.

We are indebted to both these bodies for the help they have given.

Survey of backsiphonage incidents

3.02. We considered that our first task should be to obtain information concerning actual cases of backsiphonage. To this end, and at our request, the Institution of Water Engineers sent a questionnaire to all chief officers of water undertakings in the United Kingdom who were members. The questionnaire asked for brief details of cases of backsiphonage and sought opinions on the adequacy or otherwise of the backsiphonage prevention requirements in the current (1966 issue) model water byelaws. A number of cases reported were recent, others had occurred a number of years ago.

3.03. Of the 190 questionnaires sent out, 119 were returned. 67 engineers reported that no known cases of backsiphonage had occurred in their undertakings, whilst 52 engineers reported a total of 120 cases. Of these 120 cases, 78 arose in connection with industrial supplies, 22 with domestic supplies, 15 on farm supplies and 4 in hospitals. The remaining case occurred during a mains repair. The results are analysed in Table 3.1.

The following conclusions are drawn from this table:

(a) The preponderance of reported incidents arose from industrial installations.

(b) The use of silencing pipes on inlets to cisterns and of check valves which are, or have become, ineffective are examples where potential backsiphonage situations could subsequently arise.

(c) Temporary hose connections, particularly in industrial premises, could be a major hazard.

Of all the incidents reported, only three were brought to light by reports of sickness amongst consumers; the remainder had been revealed by changes in taste, colour or temperature of the water supplies, or by routine inspection. The extent of other instances which must be presumed to have occurred, but have passed unnoticed or unrecorded, can only be a matter for speculation. Of the three incidents which caused sickness, the first occurred in domestic premises and was caused by a Fire Brigade inadvertently pumping water from

Table 3.1

Analysis of Replies to the IWE Questionaire

Cause of incident	Type of Installation: Industrial	Domestic	Farm	Hospital	Total
Cross-connection between a public water supply and a pipe carrying water from another source	37	4	3	1	45
Failure of check (non-return) valve	15	3	1	–	19
Submerged inlets (including silencer pipes to cisterns)	3	7	4	–	14
Other non-compliance with byelaws	10	4	1	3	18
Temporary hose connections	9	3	3	–	15
Ball hydrant	1	–	–	–	1
Gully emptier	1	–	–	–	1
Accidental and miscellaneous	2	1	3	–	6
	78	22	15	4	119
Mains repair	–	–	–	–	1
					120

a river through a hose connected to a hydrant. The second affected office staff using a coffee machine and was attributed to backsiphonage from a urinal bowl in which the outlet of the directly connected flush pipe discharged below the overflow level of the bowl. The third incident was on industrial premises where the mal-functioning of two non-return valves placed in series resulted in the backwash from a softening plant containing chlorides of calcium, magnesium and sodium being supplied to drinking water taps in the neighbouring workshops and offices.
A summary of the reported cases, with preliminary conclusions, was set out in our Progress Statement (April 1971) which was circulated for comment to all statutory water undertakers and to other interested bodies and individuals.

3.04. In addition to the foregoing, we received further information concerning backsiphonage incidents in this country and overseas. The following selection illustrates widespread and variable backsiphonage situations which could have been serious.

England

1. In a hospital, a service pipe was shut off with the result that the contents of a number of sluice sinks backsiphoned into the service pipe.
2. In a dock area, backsiphonage occurred from a ship's ballast tanks which eventually contaminated the water supply of a canteen on shore.
3. A number of illnesses in houses near a gasworks were attributed to a possible cross-connection between a public main and an impure source.
4. Water supply to a greenhouse through a hose was taken to a cistern used for mixing fertilisers. The supply was left running with the hose outlet submerged and when a tap in a cottage situated further downhill was turned on, green fertiliser solution emerged.
5. In three separate incidents involving laundries, kitchen taps in nearby houses delivered (a) discoloured hot water (traced to the failure of 3 check valves in series directly connected to the main) (b) hot water and steam (c) water tasting of paraffin oil derived from a pressure vessel directly connected to the mains.

Australia

A hose connection submerged in a vat of cyanide in an electroplating shop resulted in contaminated water issuing from a tap on the floor below.

Belgium

A temporary hose tap fitting used to fill a cistern on a building site resulted in contamination of the mains.

France

1. Numerous cases of illness from cross-connections between potable and non-potable supplies in a large city.
2. The contents of an aquarium were backsiphoned to an adjacent apartment.
3. The drain tap from a hot water system was connected to a blocked waste pipe and backsiphonage caused by subsequent low pressure occurred causing serious contamination.

Poland

Another case of the contents of an aquarium being backsiphoned.

New Zealand

A hose connection submerged in a container of arsenical weed killer in a plant nursery resulted in contamination.

United States of America

The most thoroughly investigated case of traced backflow occurred in two hotels during the Chicago Worlds Fair in 1933; in that case there were 1,409 cases of dysentery and 98 deaths [a].

3.05. The replies to the questionnaire and comments made on the Progress Statement have enabled us to identify those appliances and fittings most likely to be involved in backsiphonage situations. They are:

A. Where mains could become directly contaminated

1. Cross connections which permit non-potable water or water not supplied by the water undertaker to gain ingress to the undertakers mains.
2. Defective mains and fittings, for example air valves in inadequately drained chambers.
3. Gully emptiers and other mobile equipment; hydrants and similar fittings.
4. Permanent and temporary fire fighting connections.

B. Where consumers' installations, and thereby water in the undertakers' mains, could become contaminated:

1. Hose connections to taps.
2. Ballvalves with outlets which are liable to be submerged in (see 3.14(c))
   i. Drinking troughs
   ii. Storage and feed cisterns
   iii. Flushing cisterns
3. Clothes and dish washing machines
4. Water softeners
5. Below ground hose or other connection points which could become submerged under contaminated water
6. Bidets, including those in hospitals and clinics
7. Mixer fittings
8. Water storage heaters
9. Pressurised hot water supply or central heating installations
10. Check valves in consumers' installations
11. Ships and other vessels
12. Haemodialysis machines (in dwellings)

The order in which the appliances and fittings have been listed above is without regard to their relative importance.

(a) Epidemic of Amoebic Dysentery. The Chicago Outbreak of 1933. Nat. Inst. Health Bul. 166 (1936).

3.06. The situations listed in 3.05-A are directly concerned with public water supply mains connections which could result in non-potable or contaminated water gaining ingress to mains and include cross-connections from private or industrial supplies and temporary fire fighting connections. Defective mains apparatus, such as a ball hydrant, forms a ready means for the ingress of polluting material. The replacement of ball hydrants by safer types has been strongly recommended and many water undertakers have already done this (Safeguards to be adopted in the operation and management of waterworks, MHLG 1967 HMSO). The present precautions taken at automatic sprinkler installations are referred to in paragraph 2.04. These matters have been examined by a competent technical committee who advises the FOC of safeguards necessary to prevent contamination of the mains. We accept the review and find that the amendments the technical committee proposed to the FOC Rules, now incorporated by the FOC, bring the Rules generally in line with the recommendations in this report.

The use or misuse of the water undertakers' mains, or temporary connections made directly thereto, could be said to be under the water undertakers' control and indeed in some cases contamination could be caused by the undertakers' own operations (see paragraph 2.02). For fire fighting purposes fire authorities and other authorised people may make connections to fire hydrants and the water undertaker may have difficulties in control. In addition, many temporary connections are made for supplies to building sites, contractors, street cleaning etc. Connection by authorised persons are made by agreement with the water undertaker, additional powers are not needed and we do not recommend any special measures other than those set out in paragraph 3.07.

Nevertheless we recognise the dangers which arise from these connections. The only practicable remedy is more effective control by the water undertaker who will have to determine the level of inspection needed to protect the quality of water in his mains.

3.07. Mobile appliances, temporary standpipes in general and gully emptiers in particular, are cases where backsiphonage could occur when temporary connections are made to hydrants or other water draw off points on a main. Water undertakers should exert pressures on users of these appliances and must maintain constant vigilance to ensure that the only types of mobile appliances used are those which are designed and constructed to eliminate all possibility of direct connection between any contaminated part of the appliance and the public water supply mains. We recommend that all mobile appliances should incorporate Type A air gaps (see paragraph 5.08) at the inlets and the connections should be so designed that water can be fed in to the appliances only at those points. In addition, a check valve should be incorporated in each filling standpipe.

3.08. The group of situations listed in 3.05 B is covered by byelaws with which the water undertaker may prescribe precautions a consumer should take to protect the quality of the water supplies. Our more detailed work has been concerned with these measures.

3.09. After examination of the recorded incidents of backsiphonage, it has become clear that separate consideration should be given to different uses of water according to whether they be for domestic, industrial process, hospital, shipboard or agricultural purposes. It is important not to lose sight of the fact that water may be used for several purposes on the same premises (See Chapters 7-12 inclusive). For example, water may be used for domestic purposes within a factory canteen. It is important to differentiate between use and the place where water is used.

Survey of domestic installations

3.10. An investigation, complementary to that carried out by the Institution of Water Engineers, was undertaken for us by the Water Research Association. The object of the investigation was to obtain information on the extent and location of potential situations where backsiphonage might occur within domestic installations.

3.11. A survey was carried out with the co-operation of 26 water undertakers who each inspected about 50 domestic properties, thus providing a total sample of approximately 1,300 properties. The inspection of each property involved filling in a report form by the undertaker's Inspector and also the taking of water samples for the purpose of chlorine residual determination and bacteriological examination. The information obtained by the report fell into three categories:

(a) Information relating to the type of property—age, type of ownership and rateable value.
(b) Details of fittings and plumbing installations with particular reference to the byelaws.
(c) The result of bacteriological examination and chlorine determination of water samples drawn from storage cisterns and from taps fed directly off the service pipes.

The criterion used, to determine whether there was a hazard situation in a particular property, was conformity with the byelaws of the water undertaker. This does not necessarily mean in each case where 'hazard' was reported that backsiphonage would occur under reduced or negative pressure conditions.

3.12. The summary of the findings of the survey are listed in Table 3.2. More detailed information is published in Water Research Association Technical Publication TP.82 'Report on the Investigation of Backsiphonage Risks in Domestic Properties Winter 1970/71', obtainable from the Association.

3.13. The results given in Table 3.2 item 14 call for special comment. Absolute values of plate count may vary considerably depending on the nature of the source of the water and the time of year. However, a plate count ratio may be regarded as significant when it exceeds 100. Such a water, showing a deterioration in its quality, would not necessarily be harmful to health although it might give rise to complaint of taste and odour.

Table 3.2

Type of Backsiphonage Hazard Situation

	DEFECTS AS A PERCENTAGE OF THE INSTALLATIONS SURVEYED*
1. Installations containing elements which contravene specific byelaws relating to backsiphonage and/or might allow backsiphonage to occur during periods of low or zero mains pressure.	61
2. as 1 but relation to age of property	
(a) less than 5 years old,	36
(b) between 5 and 15 years,	63
(c) greater than 15 years	84
3. as 1 but including installations with temporary connections to taps fed by service pipes and/or connections of a semi-permanent nature.	85
Particular hazard situations	
Storage Cisterns	
4. Having no covers	32
5. Inlet not discharging above level of overflow pipe (byelaw 39)	20
Flushing Cisterns	
6. Air gap less than one inch (25mm) (byelaw 40)	14
Taps	
7. Air gap less than ½ inch (12mm) (byelaw 53)	23
Handsets and bidets	
8. Pipes which supply a submersible discharge point and also supply taps and fittings at a lower level (byelaw 53)	30
Cross-connections	
9. Cross-connections between service and distributing pipes (byelaw 8) (includes taps which contravene byelaw 47)	3
Temporary connections	
10. Installations where temporary connections are made to taps on service pipes	57
Proportion of potential hazard situations where contamination could occur	
11. Mains system at hazard	63
12. Hazard restricted to the installation	8
13. Unknown situations where a tap may or may not be connected directly to the mains system.	29
Bacteriological investigation	
14. Ratio of plate counts: water drawn from storage cistern / water drawn from service pipe	
(a) in range 0–10	85
(b) in range 10–100	11
(c) greater than 100	4

15. From 426 of the 1300 properties water samples were taken and tested for E. coli and coliform bacteria. Coliform bacteria were only found in the mains supply of 5 installations and in the storage cistern water of 11 others. E. coli bacteria were not detected in these 16 installations. In one other installation coliform and E. coli bacteria were detected in both the mains supply and in the storage cistern water.

*The percentages quoted are accompanied in the detailed report mentioned in the text by the appropriate confidence intervals.

Conclusions

3.14. We have drawn the following conclusions:

(a) The existence of byelaws will not ensure adequate protection against backsiphonage unless installations are regularly inspected and the requirements of the byelaws are enforced.

(b) Temporary connections to outlets, which are in turn connected directly to supply pipes, represent a frequent hazard not only because of the ease with which they are made, but also because there is considerable variation in the types of appliance which may be fitted this way. It should be noted that the data available from the survey does not enable us to assess the effect of contamination which could occur as a result of backsiphonage.

(c) Water drawn from domestic storage cisterns has not been found to deteriorate to any significant extent in respect of bacteriological quality. However, uncovered cisterns, have shown some diminution in quality. Therefore, we believe that the results indicate that where a storage cistern is adequately covered and does not receive water other than that supplied by the water undertaker, backsiphonage of stored water would not be harmful to health and would not present a hazard to the mains system.

4

Classification of potential Backsiphonage situations

4.01. In our consideration of the hazards of backsiphonage, we have taken into account the replies to the questionnaire circulated by the Institution of Water Engineers, the comments received on the Progress Statement and the results of the survey of domestic installations (see Chapter 3).

The subject is complex because of the variety of circumstances in which water is used. Nevertheless, we have found it possible to rationalise in broad terms.

We have been concerned with two important factors:

(a) the likely consequences following a case of backsiphonage; and

(b) the likely occurrence (or frequency of occurrence) of backsiphonage.

4.02. The consequences of backsiphonage are largely influenced by the nature of the contaminant which might be introduced into water mains and installation pipes, either accidentally or otherwise. They also depend on the use that is made of the water. Industry, trade, manufacture, docks and so on not only require water for industrial and commercial purposes but also for drinking and other domestic uses by staff in canteens and toilets. We have principally concerned ourselves with risk to health from contamination of any water which may be used for the latter purposes. We have not concerned ourselves with the effects of backsiphonage on water used in other ways.

4.03. The frequency of occurrence of backsiphonage is influenced by (a) the use made of water using appliances and fittings which are connected to the public water supply and (b) how prone an installation may be to the occurrence of backsiphonage. The overall protection afforded directly affects the extent to which an installation may be contaminated. Only to a much lesser extent will it affect consequences once backsiphonage has occurred. Because no system of prevention is infallible, in classifying risks, we have given greater weight to the consequences of backsiphonage than to the likely frequency. The result is bound to be subjective because we are attempting to combine dissimilar factors in a single system.

4.04. With the above in mind, we have classified potential backsiphonage situations into three classes of risk in descending order of magnitude, as follows:

Class 1: Risk of serious contamination which is likely to be harmful to health (continuing or frequent).

Class 2: Risk of contamination by a substance not continuously or frequently present which may be harmful to health.

Class 3: Risk of contamination by a substance which is not harmful to health (but which could give cause for complaint by consumers).

4.05. In formulating these classes, we have had regard to those situations which, according to the information available, have, in our view, resulted or could result in contamination of potable water. The following are examples of those circumstances, installations and appliances which in practice may involve one of the foregoing classes of risk:

Class 1

(a) In the home
Bidets, WC pans, Dialyzer washing equipment (home haemodialysis machines)

(b) Hospitals and other premises using medical equipment (additional to (a) above)
Laboratories, research centres, dental surgeries, mortuaries, dissecting rooms. Bed pan washers.

(c) Industrial commercial and trade premises (additional to (a) above)
General process use, research centres and laboratories, mobile tanker vehicles, degreasing and car washing plants (other than hand operated), hose union taps and launderettes

(d) Agricultural premises (additional to (a) above)
General agricultural use (such as cooling, chemical dilution), animal drinking troughs, mobile tanker vehicles and hose union taps

(e) Miscellaneous
Cross-connections between public mains and private water supplies, fire fighting supplies; ship-shore connections; gully emptiers, mobile tanker vehicles, sewer cleaning machines, ejectors; hose union taps.

Class 2

(a) In the home
Taps at sinks, baths and washbasins; domestic clothes and dishwashing machines; hose union taps (garden or garage); flushing cisterns; flexible shower fittings (attached to or for use at a bath or basin) boiler primary circuits and central heating systems (indirect) including associated feed cistern.

(b) Miscellaneous
Automatic drink vending machines; degreasing and car washing plants (hand operated); hot water cylinders and secondary circuits at calorifiers in laundries etc; water softeners

(non-domestic) and humidifiers.

Class 3

In the home

Flexible shower fittings (in a shower cabinet not forming part of a bath), mixer valve and single outlet combination tap assemblies (in certain situations), domestic water softeners; adequately covered gravity flow cold water storage cisterns; dialysis fluid proportioning systems of home haemodialysis machines.

4.06. The Tripartite Working Group has also studied the classification of risks to health. They favour the recognition of only two classes of risk and do not take into account frequency of occurrence:

Class I: Permanent or occasional possibility of contamination which may make the water harmful to health, and

Class II: Possibility of contamination which is not harmful to health but which may give rise to complaints by consumers.

We do not expect that the results of the deliberations of the Tripartite Working Group will lead to recommendations significantly different from those made by us. This is because the Group recognise two classes of protection which can be used in differing Class I situations and there is therefore an implicit recognition of two sub-classes of risk.

4.07. In the following chapters, we deal with the problems of selecting the appropriate class of device to meet the various classes of risk.

Devices designed to prevent the occurrence of Backsiphonage

Introduction

5.01. Backsiphonage may occur at nearly every part of an installation, whether at a fitting, an appliance or an installation connected to the public water supply. Reliability of the precautions taken against backsiphonage depends on every part of the installation and cannot be limited solely to reliability of backsiphonage prevention devices. Thus the inherent reliability of the consumers' system can be affected by the expertise of designers, manufacturers and installers of every part as well as by the actions of the consumer himself. In this chapter, however, we devote ourselves solely to backsiphonage prevention devices which are themselves only a part of a consumer's installation.

5.02. We define device reliability as the measure of the probability that the approved device (or combination of devices) when correctly installed will give an appropriate measure of protection against backsiphonage. Assessment of device reliability defined in this manner enables us to list available backsiphonage prevention devices in an approximate order of merit. For the sake of convenience, we have arranged this list into three classes. However, it must be borne in mind that installation conditions and other extraneous factors could affect the choice of device to be used to meet a specific situation to give the desired measure of protection.

Reliability of devices

5.03. Devices designed to prevent backsiphonage may be sub-divided into two types:

(a) Devices without moving parts and

(b) Devices with moving parts.

5.04. In order to be in a position to assess the reliability of devices, we arranged for two types of tests to be performed:

(a) Functional tests, in which the behaviour and performance of devices were assessed under specified test conditions and

(b) Endurance tests, in which the ability of the device to function satisfactorily over a period of time was assessed (that is, the continuous reliability in service and probable need for maintenance were the criteria).

Tests on devices without moving parts were carried out at the Building Research Establishment whilst most of the tests on devices with moving parts have been undertaken at the testing station of the Standing Committee of the British Waterworks Association at Staines. Comprehensive and numerous tests were devised and carried out for each particular device. Devices included a number of proprietary products but we do not claim to have evaluated all possible variations of design. Our object was to test a wide range of each category of device to enable us to assess its overall value. A number of in-service tests were carried out at various sites under service conditions and we wish to record our appreciation of the helpful co-operation of water undertakers, hospital authorities and their staffs in various parts of the country in making these tests possible.

5.05. This lengthy test programme makes us confident that the classification we propose in Table 5.1 is the best that may be drawn up with present knowledge. We recommend that work on the evaluation of devices and the improvement of test methods, particularly on devices with moving parts, should continue. This work is important in view of the move towards international

Table 5.1

Classification of Backsiphonage prevention devices

Class of Protection	Device
1	Type A air gap
	Break pressure cistern with a Class 2 device on the inlet and from which water flows only by gravity
2	Type B air gap
	Pipe loop
	Pipe interrupter
	Combined check and in-line anti-vacuum valve
	System including a. terminal anti-vacuum valve b. check valve
3	Anti-vacuum valve (terminal type)
	Anti-vacuum valve (in-line type)
	Check valve

harmonisation of test methods and criteria. When devising test criteria, particular attention should be paid to the long term effects under service conditions of temperature, scale deposits and corrosion, and the effects of wear and adhesion of moving parts.

Devices without moving parts

5.06. The following devices without moving parts have been assessed:

(a) Type A air gap (App 1)
(b) Type B air gap (App 1)
(c) Pipe interrupter (App 2)
(d) Pipe Loop (App 3)
(e) Vent pipe
(f) Pipe upstand

5.07. A properly constructed air gap is most effective in preventing backsiphonage. We have identified two forms which differ from each other in principle and we have formulated test criteria for each.

5.08. The principal characteristics of the *Type A air gap* are that the vessel receiving flow has an unrestricted overflow and an accessible and measurable vertical safety distance must exist between the lowest part of the inlet (which discharges downwards in a sensibly vertical direction) and the level of the overflow (see Fig 1).

5.09. The principal characteristics of the *Type B air gap* are that the vessel receiving flow may have an overflow which is not unrestricted. A finite vertical safety distance must exist between the lowest part of the inlet (which need not discharge vertically downwards) and the water level in the vessel at the time that the overflow is passing a specific inlet flow.

5.10. The *Type B air gap* depends for its continued reliable operation during the whole of its working life on the overflow remaining unobstructed. The Type A air gap is free of this disadvantage and is clearly the more reliable of the two devices. A feature of these air gaps is the loss of water pressure which results. In each case, water is released to atmospheric pressure.

5.11. The *pipe interrupter* is usually installed in a relatively small diameter pipe not subject to mains pressure and is often located downstream of a flow control device, such as a valve (See photograph 11). Water passes through a section of pipe into which air may be drawn through holes or slots. Its principal characteristic is that as soon as sub-atmospheric conditions arise upstream of the device, air is drawn into the pipe through the air holes but not before there has been a small rise in water level in the downstream pipe. Because of this, a safety distance must exist between the air holes and the potentially contaminated liquid downstream of the device.

5.12. The *pipe loop* is a rarely used device consisting of a tall inverted U tube. Its successful operation depends on it being high enough so that under backflow conditions, any siphonic action is broken by vapourisation in the water column. In practice, a height of 10.5m has been found to be adequate under free flow conditions. The pipe loop is particularly susceptible to downstream conditions, especially if there is any possibility of pump induced reverse flow. The safety distance (of 10.5m) should exist from the highest possible equivalent free water level at any branch connected to the downstream leg.

5.13. A *vent pipe* is a vertical extension of the outlet pipe from a storage cistern. Its upper end is open to the atmosphere and is installed in a similar manner to an expansion pipe. The lower end connects with the outlet pipe downstream of the cistern isolating valve. In association with an upstand, sub-atmospheric conditions may be prevented from arising within distribution pipework from storage cisterns at times when the isolating valve might be closed. (See also paragraph 8.02.)

5.14. An *upstand* is a requirement which ensures that a lateral distribution pipe is connected with the supply pipe, or draw-off pipe from a cistern, at a safety distance above the highest free water level in any appliance draw-off point or fitting served from it. Appliances and fittings served from ceiling level (in both pressurised and stored systems) and those at the level of the lowest floor (only in stored systems) almost always meet this requirement. Upstands are generally used in association with vent pipes (stored systems) or terminal anti-vacuum valves and check valves (pressurised systems).

5.15. We are also aware of a device known as the subsidiary outlet. This is a divided inlet to a cistern, one leg of which discharges above the water level and incorporates an air gap. It is at present under investigation in the French Building Research Centre (CSTB), and we have not included it in our assessment because we have doubts about its value.

Devices with moving parts

5.16. The following two principal categories of devices with moving parts have been assessed:

(a) Check valves (App 6)
(b) Anti-vacuum valves (App 7 and 8)

Assessment of these devices is more complex than that of devices without moving parts. It is necessary to consider the possibility that adhesion, scale formation, corrosion, suspended matter in the water, and so on may impede the proper functioning of moving parts.

5.17. The *check valve* is known under a variety of names, including swing flap valve, non-return valve, reflux valve and backflow preventer. It is a device which is designed to permit flow in one direction only, opening automatically when the pressure in the direction of flow upstream of the valve is greater than the pressure downstream. In cases of reverse pressure or backflow, or if there is no flow, the valve should close.

Some existing designs are suitable for use only in a horizontal pipe whilst others may be used in any position. For the smaller sizes of pipework there are several types, including:

(a) devices incorporating gravity or spring-loaded element(s) (see photograph 7)
(b) devices in which rubber sleeves are expanded by the passage of water in the forward direction; reverse flow is prevented by the contraction of a sleeve onto a seat (see photographs 5 and 6).

Check valves can fail to close for a number of

reasons. Complete failure may occur either as a result of material failure or as a result of the lodgement of foreign bodies contained in the water or as a result of the effects of scaling (see photographs 13 to 20).
In the present state of development of the check valve, the results of our tests show that this valve provides only a low degree of protection, particularly where scaling is likely to occur. However, there are circumstances when it can make a useful contribution, particularly in conjunction with another device.
5.18. There are two categories of *anti-vacuum valve,* an in-line device and a terminal device. An in-line device is installed in a pipe through which water normally flows to serve fittings and appliances downstream (see photographs 10 and 12). It has one or more air inlets against which a flexible seal is held by the water pressure so that the air inlets are closed under normal flow and pressure conditions. As soon as pressure at the device falls below atmospheric pressure, the seal falls away from the inlets to admit air and thus prevent backflow. A terminal anti-vacuum device is installed on a vertical branch pipe through which water does not normally flow. This device incorporates a sealing mechanism such as a float or a gravity operated member which is held against air inlet ports by water pressure. The former type can also act as an air release valve.
We consider that terminal anti-vacuum valves installed off-stream offer a higher degree of reliable protection than check valves because the effects on the former of scaling, corrosion and deposition of suspended matter would be limited. Anti-vacuum valves do not afford any protection against pump induced reverse flow.
5.19. We are also aware of a backflow prevention device which is used in the USA based on the principle that water will not flow from a zone of low pressure to one of high pressure. The device consists of two spring-loaded check valves and a spring loaded diaphragm-operated differential pressure relief valve located in the zone between the check valves. We have not had the opportunity of assessing the reliability of this device, but it is rather expensive and elaborate and requires a drain.

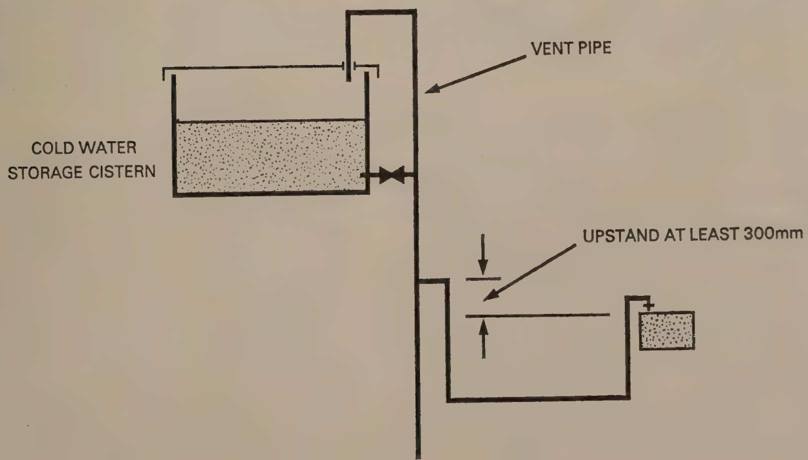
Devices used in combination
5.20. The inherent reliability of a system of protection consisting of two or more dissimilar devices with moving parts installed in combination is higher than that of two similar devices installed in combination (see photographs 8 and 9). This fact has been taken into account in arriving at our assessment of devices (see Table 5.1). For instance, we consider that Class 2 protection can be effected by two Class 3 devices in combination. However, in no instance do we consider that a Class 1 risk can be met by other than a Class 1 device.

Quality assurance
5.21. The preceding paragraphs are concerned with the reliability of devices, either singly or in combination, and our classification assumes that they will be manufactured, tested and installed to

Figure 4
Stored installations

Whole Installation Protection

(Paras. 5.13, 5.14 and 8.02)



approved standards and regulations. This points to the need for a system of quality assurance involving type approval quality control, and surveillance of manufacture and inspection when installed.

Installation conditions and acceptance tests

5.22. It is necessary for installation conditions and acceptance tests to be defined for each device. We have drawn up a series of documents for those devices which we have tested and these are incorporated as Appendices to this report. Nevertheless, we draw attention to Chapter 15 which deals with continuing work. It is necessary for such documents to be supplemented and amended from time to time.

Classification of protection afforded by various devices

5.23. Three classes of backsiphonage risk have been identified (see paragraph 4.04). The devices listed in paragraphs 5.06 and 5.16 may be related, as appropriate, to each class of risk. In some cases, all that may be necessary is to install the device in a pipe (for example, a check valve) or at a draw-off point (for example a tap installed above the overflow level of a sink). In other cases, two devices may be used in combination, or a device may be used in association with an appliance, such as a break pressure cistern. On the basis of present knowledge, we have placed devices in one of three classes of protection as follows in paragraphs 5.24 to 5.26. However, we must mention here as elsewhere in our report, that the relationship is somewhat subjective and systems of safety devices other than those described in the report are possible. Table 5.1 summarises paragraphs 5.24 to 5.26.

5.24. *Class 1 protection*

(a) the normal and most reliable protection against a Class 1 risk is the Type A air gap (see para. 5.08). Providing adequate precautions are taken against the device being tampered with, complete protection is assured against backsiphonage of contaminated liquid from associated appliances.

(b) an approved break pressure cistern may be used, providing flow from the cistern is by gravity at all times and no pump or pressurised vessel is permitted downstream (examples of applications include supplies to W.C. pans, industrial process water and the like). Our recommendations concerning the break pressure cistern (that is, its location in relation to the Class 1 risk and the appropriate safety devices to be used in conjunction with it) are incorporated in the Appendices to this report.

5.25. *Class 2 protection*

(a) Type B air gap (see paragraph 5.09)
(b) Pipe interrupter (see paragraph 5.11)
(c) Pipe loop (see paragraph 5.12)
(d) Vent pipe on the outlet from storage cisterns in association with upstands, in stored systems (see paragraphs 5.13, 5.14)
(e) Combined check and anti-vacuum valve (see paragraph 5.20) installed, for example, at a garden hose union tap connection
(f) Anti-vacuum valve (terminal type) and check valve.

5.26. *Class 3 protection*

The following devices installed on their own will afford Class 3 protection:

(a) Anti-vacuum valve (terminal type)
(b) Anti-vacuum valve (in-line type)
(c) Check valve

6

Principles for protection against Backsiphonage

General

6.01. To assist us in formulating our recommendations, we devised six principles:

(a) Water for drinking and other domestic uses should be protected against contamination up to all draw off points by mandatory requirements. As far as it is practicable and economical to do so, the consumer should be protected against his own folly, that of his own agents and that of third parties.

(b) The water undertaker should continue to have undivided responsibility for the maintenance of protection of water in public mains against contamination from any cause.

(c) Three classes of backsiphonage risk may be identified; appropriate classes of protective device may be related to a particular class of risk.

(d) Risks of backsiphonage should be eliminated as far as economically possible.

(e) Backsiphonage prevention devices should be constructed and installed in such a way that they can be inspected, tested and maintained but cannot easily be tampered with.

(f) The choice of device appropriate to the risk against which protection is required should be made having regard to the reliability of the device.

6.02. The following discussion amplifies certain aspects of these principles.

It is essential that protection against backsiphonage should be capable of being enforced. We also believe that protection at the point of use should be the first line of defence.

Water undertakers may decide that it is necessary for them to install and maintain protection to safeguard water in their mains in addition to that afforded at the point of use. The maintenance of adequate mains pressure does not guarantee protection.

Although we believe that Type A and Type B air gaps should be the mainstay of protection at the point of use, we recognise that the air gap may have a number of disadvantages from the consumers' point of view, despite it being, in most cases, not only the most effective device but also the cheapest. We consider that it would be unnecessarily restrictive to require a Type A, or even a Type B, air gap to be the only authorised means of protection. For this reason, we devised a classification for devices other than the air gap (see Table 5.1) and related them to the various classes of risk.

Measures taken to prevent backsiphonage from an installation, including the types, numbers and disposition of devices could have important cost consequences for the consumer; too rigid an approach to the prescription of requirements for protection could be restrictive as well as being unnecessarily expensive.

Devices to prevent backsiphonage should be designed so that there would be no incentive for an installer or consumer to tamper with them.

Flexibility is needed in the prescription of requirements to enable devices to be selected for use bearing in mind the extent of inspection and maintenance which the device is likely to receive in service conditions. What may be suitable in one installation, supervised and maintained by qualified staff, may not be suitable for use in another installation.

The future

6.03. Although our recommendations cover most of the risk situations which arise at present, we consider there will be need for continual review to ensure that mandatory requirements encourage, and do not inhibit, future development.

6.04. We consider that mandatory requirements should be expressed in unambiguous terms and there should be a uniform system of interpretation of those requirements.

7

Protection of water in the home and domestic use elsewhere

Protection built into installations and appliances

7.01. Our recommendations for protection of water in the home are based on protection at every point of use. In this way, the consumer is afforded protection within his premises and in addition, protection is provided against contamination of water in the public mains.

7.02. There are two kinds of potential backsiphonage hazard in connection with the domestic use of water. The first lies within the plumbing installation (for example, backflow from an upper to a lower floor or cross-connection between heating water and drinking water) ; this can be prevented by correct design of the pipework and layout within the installation associated with the use of appropriate protective devices. The second situation arises from fittings and appliances connected to the installation at points of use of water. An appropriate approved safety device should be provided at each point of use either at the water outlet or built into each appliance connected to the installation. The device should be designed and constructed so that it cannot easily be tampered with. Devices should be fitted irrespective of whether other devices are included in the installation or not.

Noise from ballvalves which discharge above water level into domestic flushing and storage cisterns is a source of complaint. In Chapter 2 we have referred to the wide use of silencing pipes attached to the outlet of ballvalves. Whilst we accept the need to avoid noise in plumbing installations, especially in domestic installations and in buildings such as hospitals, the small air hole conventionally provided in ballvalves to prevent backsiphonage would not satisfy the test criteria for a Class 2 device. We recommend that silencing pipes should be permitted for use in association with ballvalves providing suitable Class 2 protection is afforded.

7.03. Built-in protection may be provided in several ways. For instance, clothes washing machines incorporate protective devices within the machines. Draw-off taps should have a prescribed pillar height to match the equivalent tap 'base to rim' dimension of each basin. To ensure that such devices are included, fittings and appliances must be tested and approved. It is not enough to inspect after connection to the installation.

Inspection and safety of installations

7.04. In Chapter 14 we deal with enforcement of our recommendations. We recognise that maintenance of domestic installations is likely to be limited and inspection infrequent. We consider that maximum reliance should be placed on devices without moving parts. These require little or no maintenance and are therefore less likely to be tampered with than devices with moving parts. Although our tests on some devices with moving parts, particularly check valves, have not been conclusive (see paragraph 5.17), we are able to recommend that these devices may be permitted in certain situations providing the conditions of use are carefully specified and enforced. In particular, certain types of anti-vacuum valve are effective and reliable if they are used in conjunction with an approved type of check valve (see paragraphs 5.20 and 5.25). Check valves and anti-vacuum valves may be used by themselves in low hazard situations to give a measure of protection.

Boiler and central heating circuits (heating water)

7.05. Water is used as the heat transfer medium in domestic central heating and hot water supply systems. Heating water from the boiler (which may be gas, solid fuel or oil-fired) is conveyed in the primary circuit to radiators and hot water cylinders (calorifiers) before return to the boiler. In some instances, pumps are installed in radiator circuits to compensate for the use of small bore tubing to ensure that the radiators operate efficiently. Corrosion inhibitors are commonly used in boiler and central heating circuits and we cannot foresee what other chemicals are likely to be used in future. Because of these risks, we recommend that all make up water used in domestic boiler and central heating installations should be fed through a Type B air gap or equivalent. In most cases, this implies supply through a break pressure feed cistern with gravity flow to the circuit.

Hot water supply

7.06. We define hot water as heated water for use at a draw-off point. It includes water in secondary circuits of indirect heating installations, instantaneous heating appliances, and direct heating circuits in which heating, for example, by an electric immersion heater, is thermostatically controlled. The requirement of an air gap in the cold water feed to the hot water supply system has prevented the introduction into the United Kingdom of pressurised hot water supply installations. Similarly, a prohibition of cross-connection between hot and cold water installations has led to the development

of double outlet type combination tap assemblies peculiar to the United Kingdom.

Although we recognise that the ingress of hot water into drinking water installations is undesirable and in certain circumstances can cause scalding we consider it is not in itself a contamination hazard to health.

In our view, hot water which is first drawn from a properly covered cold water storage cistern should be classified only as a Class 3 risk. Because of this, in certain circumstances (see paragraph 7.07) we classify the single outlet type combination tap assembly and mixing valve as a Class 3 risk, and we consider that in such cases a Class 3 device, such as an approved type of check valve, would give adequate protection against the ingress of hot water to the mains.

We have examined two types of domestic hot water system used in the United Kingdom and also a system commonly used abroad in the light of the above conclusions.

These systems are, respectively:

(a) Stored installations, in which hot and cold water are supplied by gravity flow from storage cisterns (except for one cold water tap for drinking purposes and possibly an outside tap in a garden or garage).

(b) Unbalanced installations, in which hot water is supplied by gravity flow from storage cisterns, cold water is fed directly from the mains.

(c) Fully pressurised installations, in which hot and cold water are fed directly from the mains.

7.07. *Stored installations*

Providing each point of use is equipped in accordance with our recommendations in Tables 7.1, 7.2 and 7.3, no further precaution should be necessary. Single outlet mixer taps can be permitted as at present at sinks and showers where both the hot and cold water are drawn by gravity flow from cold water storage cisterns. However, a cold drinking water tap is usually situated in the kitchen and it is served directly from the supply pipe under pressure from the public main. The kitchen is a point where there is a great demand for a hot and cold water mixer tap. As stated in paragraph 7.06, single outlet type combination tap assemblies and mixing valves when protected by a Class 3 device such as an approved check valve can be permitted as an alternative to the double outlet type. We draw attention to the difficulties involved in designing suitable single outlet type combination tap assemblies and mixer valves to suit unbalanced pressure conditions. In these circumstances, there is a possibility that excessive mains pressure, if uncontrolled, could cause water to flow through these fittings into the hot water system when both inlets are open. We draw attention in para 7.09 to possible problems which might be caused if hot water gets into a cold water installation.

In stored systems, the expansion pipes associated with the secondary circuit are usually located so as to discharge water into the cold water storage cistern. Water discharged through the expansion pipe might affect adversely the quality of the cold water in the cistern and might cause corrosion of the cistern but is not otherwise likely to give rise to any problems.

Should a break pressure feed cistern be used with the boiler and central heating system (see paragraph 7.05), the associated expansion pipe should not discharge into the cold water storage cistern nor should the overflow from the feed cistern be led to the storage cistern.

7.08. *Unbalanced installations*

Providing each point of use is installed in accordance with our recommendations in Tables 7.1, 7.2 and 7.3, no further precautions should be necessary. Double outlet type combination tap assemblies or alternatively single outlet type combination tap assemblies and mixer valves suitably protected by Class 3 devices can be permitted. As stated in 7.07, there are design problems associated with unbalanced head conditions at single outlet type combination tap assemblies and mixer valves.

7.09. *Fully pressurised installations*

The fully pressurised system is standard in many other countries eg in the USA, Canada, Japan, USSR, Continental Europe, S. America, Australia (optional), S. Africa (optional), New Zealand (optional). We recommend that with suitable protection, fully pressurised installations should be permitted in the United Kingdom, providing there are no cross-connections between primary and secondary (heating and hot water supply) circuits. Because pressures at the cold and hot water inlets are balanced, single outlet type combination tap assemblies and mixing valves may be used without a Class 3 device in the cold water inlets. Each point of use should be protected in accordance with our recommendations in Tables 7.1, 7.2 and 7.3.

We have considered whether a check valve should be installed on the cold water inlet to calorifiers and hot water cylinders to prevent hot water flowing back into the cold feed pipe and possibly the mains. We draw attention to problems which arise when check valves are not installed, such as the effects of hot water on polythene and the possibility that in certain circumstances hot or warm water may be delivered from cold water taps within an installation. On the other hand, if check valves are installed, expansion of the hot water must be allowed for to prevent explosions or damage to the installation. We recommend that check valves should not be required to be installed on the cold water inlets to mains pressurised calorifiers and hot water cylinders at the present time. However further studies of the problems involved are needed.

Hose union taps and flexible shower hoses

7.10. In para 4.05 hose union taps in dwellings drawing water directly from the supply pipe are identified as Class 2 risks. Devices are available for attachment to garden hoses (such as lawn spraying units) and to garage hoses (such as detergent brush units). Some gardening devices include pesticide dilutors and sprayers which rely on mains pressure for their operation. Flexible shower hoses which can be left immersed in wash basins or baths also constitute Class 2 risks. In Table 7.2 we

recommend that not less than the equivalent of a combination anti-vacuum valve and check valve should be provided although any other Class 2 device would afford the necessary degree of protection.
Because we consider that installations should be designed and equipped so as to deter or remove the need for unprotected temporary hose connections, we recommend that:

(a) future relevant Codes of Practice should stress the need to locate one or more protected hose union taps in every house at carefully selected convenient points;
(b) a properly protected flexible shower appliance should be specified as a matter of course in new dwellings;
(c) the appropriate British Standard (BS) should be modified to specify that taps (other than

Table 7.1

Protection against Class 1 risks in domestic installations

Sources of risk	Recommended protection
1. W.C. pan	Approved flushing cistern with a Class 2 device on the inlet and from which water flows only by gravity.
2. Bidet	Type A air gap on both hot and cold water inlet (ie over-rim type) suitably shrouded and so designed as to deter the attachment of spray outlets.
3. Urinal	Approved flushing cistern with a Class 2 device on the inlet.
4. Dialyzer washing equipment (home haemodialysis machines)	Approved break pressure cistern from which both hot and cold water are drawn by gravity only. Class 2 device on the inlet to the cistern.

Table 7.2

Protection against Class 2 risks in domestic installations
Either the Type A air gap or any device or combination of devices shown in Table 5.1 giving Class 1 or Class 2 protection may be permitted.

Sources of risk	Recommended protection
1. Taps at sinks, washbasins and baths.	Type A air gaps preferred.
2. Water in WC flushing cistern	Class 2 device on the inlet
3. Hose union tap (garden or garage)	Combination anti-vacuum and check valve.
4. Flexible shower fitting (fully pressurised and unbalanced installations)	Combination anti-vacuum and check valve. (See also item 2 in Table 7.3)
5. Clothes and dish washing machines	Built-in Type B air gap or pipe interrupter built-in to the machines.
6. Heating water and central heating circuits (make up and filling of primary circuits)	Type B air gap.

Table 7.3

Protection against Class 3 risks in domestic installations
Any device or combination of devices shown in Table 5.1 may be permitted.

Source of risk
1. Hot and cold water mixer taps in unbalanced installations (also kitchen taps in stored installations). Device needed to prevent hot water entering cold water supply pipe.
2. Hot and cold water mixing devices at shower fittings (unbalanced installations only). In addition to the device fitted in accordance with item 4 in Table 7.2 a device is needed to prevent hot water entering cold water supply pipe.
3. Domestic water softeners.
4. Properly covered cold water storage cisterns from which water is drawn only by gravity flow.
5. Proportioning pump used in mains pressure operated dilution of dialysis fluid in home haemodialysis machines.

properly protected hose taps) should be designed so as to make it difficult to fit hoses to them.

Bidets

7.11. Bidets constitute Class 1 risks. We recommend that the over-rim type of bidet having Type A air gaps at the hot and cold water inlets should be the only permitted type.

To preserve the integrity of the protection afforded by Type A air gaps on both hot and cold water inlets, we recommend that bidets be designed in such a way as to prevent the subsequent attachment of temporary hand held sprays and the outlets of the supply taps should be shrouded to prevent their becoming fouled.

If it were not for the risks of misapplication and misuse of the alternative types of bidet (that is, bidets with hand held sprays and bidets with fixed sprays in their bases), we might have been able to recommend they be permitted for use in fully stored domestic installations, subject to restrictions on the feed pipework. Whilst we accept that many of these types of bidet are in use in existing fully stored installations, we wish to eliminate any chance that they may be used in either fully pressurised or unbalanced domestic installations in future.

Cold water storage cisterns

7.12. As stated in paragraph 3.14(c), water stored in an adequately covered cold water storage cistern from which water is drawn by gravity flow is not harmful to health and does not present a hazard to the mains system should backsiphonage occur. The survey of domestic properties has shown that a large number of cold water storage cisterns are not adequately covered (see Table 3.2, item 4) and our attention has been drawn to the inadequacy of the wording of the relevant BS and model water byelaws in this respect. The description of the requirement should be improved to remove doubts concerning what is meant by a 'suitable' cover.

We recommend that in domestic installations the covers of cold water storage cisterns should be rigid with overlapping edges and so designed that they cannot easily be dislodged. In all other cases where drinking water is involved, the description given in Model Byelaw 9 is appropriate or the cistern should be in other ways adequately protected to meet those requirements.

Domestic washing machines

7.13. Domestic clothes washing machines have been identified in paragraph 4.05 as being Class 2 risks. At the present time there are three broad categories of machine types:

(a) those with filling pipes plumbed in to the pipework in the house;

(b) those with filling pipes fixed to the machine bodies at one end, the other push-fitted to a conveniently located tap, and

(c) those which are filled by loose hoses, one end push-fitted to a conveniently located tap, the other left free to discharge in the machine.

Machines in categories (a) and (b) are usually automatic or semi-automatic machines and both types should have Class 2 or better backsiphonage prevention devices built-in to them.

7.14. Machines in category (c) include some semi-automatic types, but most are manually operated in which the only precaution which may be practicable is for a suitably spigotted free hose end to plug into or through a hole thereby providing an unreliable form of air gap. Taps are usually closed and the hoses removed before these machines are charged with laundry or detergent. Should backsiphonage occur during a filling operation, water quality in the machine should not have deteriorated to the extent that it would have become a significant danger to health.

Recommended Precautions

7.15. Our recommendations for protection against backsiphonage in new installations in dwellings and domestic use outside the home are summarised in Tables 7.1, 7.2 and 7.3, in which most common domestic fittings and appliances are covered.

Effect of the recommendations

7.16. One of the important consequences of the acceptance of our recommendations would be that the use of pressurised hot water installations would be permitted. Precautions have been recommended which would permit the use of single outlet hot and cold water mixer taps and mixer units at shower fittings in all types of domestic installations.

In two other instances, we make recommendations which would bring about change (i) hose union taps would incorporate approved devices and (ii) bidets with fixed sprays in the base or those with hand held sprays would not be permitted.

Whole installation protection

Principles of application of whole installation protection

8.01. In paragraph 7.01 we recommend that protection against backsiphonage should be afforded at every point of use in domestic installations. Should such precautions be taken in accordance with our recommendations, a high degree of protection would be ensured.
Nevertheless there are installations where the risks are multiplied either through internal circumstances, such as exceptionally heavy use of connected appliances, or to external circumstances, such as frequent low pressure conditions in the water mains. Examples are installations in buildings in multiple occupation, in canteens, or in locations where lower than atmospheric pressures are likely to occur.
In these situations such hazards as temporary connections made to taps and fittings or silencer pipes connected to ball valves in storage and flushing cisterns present a special risk and justify affording some general protection to the whole installation. This protection would be a second line of defence to that afforded at the point of use. It would give added protection to the water in the mains and could improve the protection afforded to the consumer against his own folly.
In subsequent paragraphs we describe what we mean by whole installation protection. Examples of suitable protection are summarised in Table 8.1.

Whole installation protection—stored installations

8.02. Whole installation protection would be automatically afforded to the public water mains were all supplies fed into a cold water storage cistern through an approved air gap and there were no other connections to the supply pipe.
Nevertheless, the danger to the consumer of backflow of contaminated water into pipes containing drinking water within the installation would remain, particularly in multi-storey buildings in multiple occupation where a distributing pipe from the cold water storage cistern served more than one floor.
Whole installation protection of a stored installation would include two elements (see fig 4):

(a) A vent pipe to be provided at each outlet from the storage cistern immediately downstream of the associated outlet isolating stop valve (see paragraph 5.13). Each vent pipe should (a) be taken up to a level above the top edge of the cistern and (b) should not be smaller than the largest size of pipe connected to the outlet.
In the event of the isolating stop valve being closed the vent will prevent a pressure below atmospheric occurring in the distributing pipework when a draw off tap is opened at a lower level.

(b) Requirements concerning the layout of pipework within the installation (see paragraph 5.14). All lateral distributing pipes conveying water to appliances and fittings should be connected to the distributing pipe at a safety distance above the highest water level at any appliance draw-off point, or fitting served by them. Providing an adequate vent pipe is fitted, a distance of 300mm should be sufficient to prevent backflow even if an outlet were completely submerged.

Table 8.1

Whole installation protection
(additional to protection at each point of use)

Installation to be protected	Examples of suitable protection
Pressurised installations (ie up to and including all outlets under mains pressure)	1. Terminal anti-vacuum valve, associated with 300mm upstands; check valve close to the main. 2. Terminal anti-vacuum valve associated with 1.80m upstands.
Stored installations (ie gravity fed from cisterns)	Vent pipe on each outlet from the cistern, associated with 300mm upstands.

Whole installation protection—pressurised installations

8.03. Because of requirements that a drinking water tap or taps should draw water directly from the service pipe, there are relatively few instances of installations in the United Kingdom which are not pressurised at least in part, and where failure of precautions taken at the point of use could not cause backflow into water undertakers' mains. We distinguish between those parts of installations which are fed by gravity flow from storage cisterns and those with outlets which are under pressure from the mains. In the former parts of the installation, the principles of protection set out in paragraph 8.02 should apply. In the latter parts, whole installation protection would be afforded by adopting one of the following alternatives (see Fig. 5).

(a) Three element system consisting of:
(i) An approved terminal anti-vacuum valve located on each supply pipe at the highest point of the installation and at least 300mm above the highest level at any appliance, draw-off point or fitting which is connected to the particular supply pipe. (The reliable operation of the valve depends on a minimum vacuum being established and it has been found that where a check valve is installed in the service pipe 300 mm water gauge is a satisfactory figure on which to base design and approval);
(ii) An approved check valve installed in the service pipe;
(iii) Requirements concerning the layout of pipework within the installation. All lateral distributing pipes conveying water to any appliance, draw-off point or fitting should be connected to the supply pipe a safety distance above the highest water level at the appliance, draw-off point or fitting. This safety distance should be at least 300mm.

(b) Two element system consisting of:
(i) An approved terminal anti-vacuum valve located on each supply pipe at the highest point of the installation and at least 1.80m above the highest water level at any appliance, draw-off point or fitting which is connected to the particular supply pipe. The use of a terminal anti-vacuum valve on its own, that is, without there being a check valve upstream of it, means that both the upstream and downstream parts of the installation receive protection from the anti-vacuum valve. However, if this valve is to effectively limit a vacuum pressure to within the prescribed value of 1.80m, it is necessary that the size of the valve is related to the design of the installation it protects. At present, there is insufficient practical experience to specify this relationship precisely.
(ii) Requirements concerning the layout of pipework given in (a)(iii) above except that the safety distance should be at least 1.80m.

In existing installations where whole installation protection may be considered at some future date, undue difficulty or expense might be involved in the provision of upstands. A certain measure of protection might be afforded to the mains by the use of an approved check valve located in the service pipe, in association with an anti-vacuum valve as before. In multi-storey buildings, it might be preferable for the check valve to be installed at the offtake from the rising supply pipe to each floor.

8.04. The added costs excluding maintenance costs associated with the whole installation protection of houses have been estimated (paragraph 13.07). Average figures for a new house would be as follows:
(a) Whole installation protection, provided when the house was built—£15.00.
(b) That part of (i) to facilitate the introduction of whole installation protection at a later date—£5.00.

Recommendations for requiring whole installation protection

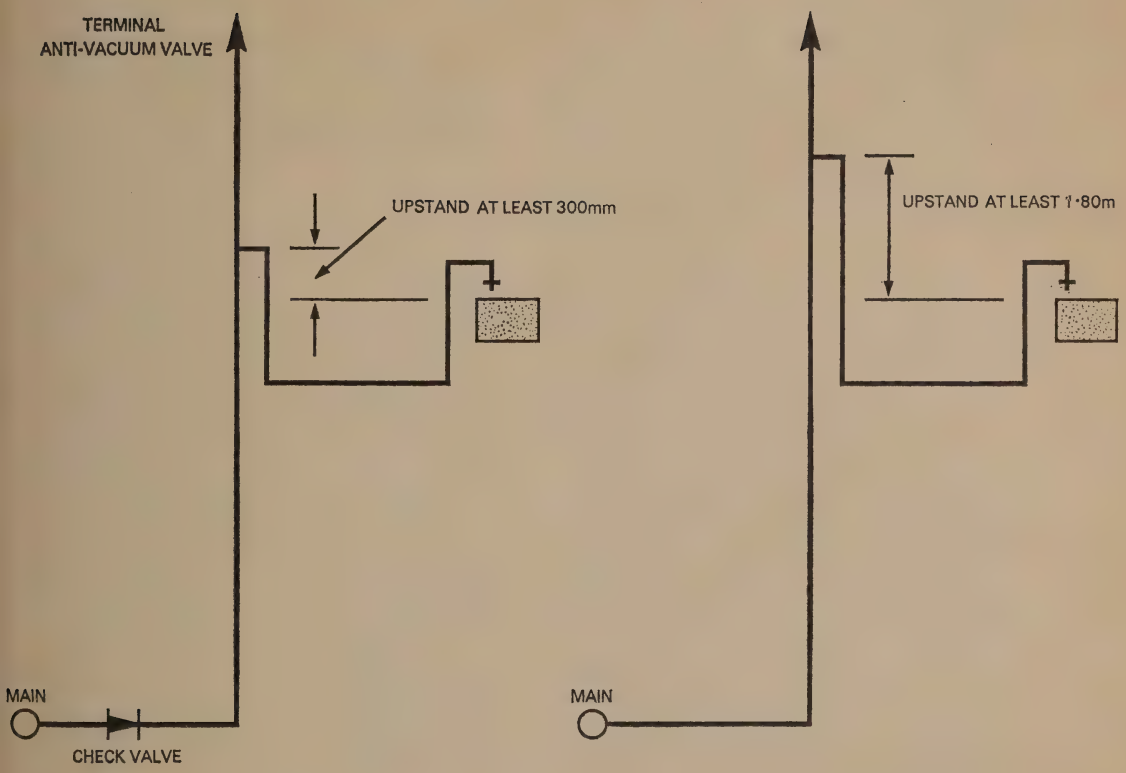
8.05. We recommend that whole installation protection should be afforded in the following or similar circumstances.
(a) in buildings in multi-occupation such as blocks of flats,
(b) in large institutions including schools, hostels, prisons and welfare centres;
(c) in premises where substantial numbers of people congregate and water is afforded for domestic use such as canteens, hotels, lavatory blocks, restaurants, sports stadia, holiday camps and commercial premises generally;
(d) in premises where s60 of the Third Schedule of the 1945 Act has been applied. In these instances, whole installation protection need only be provided on the pressurised part or parts of an installation unless the premises also fall under a category similar to (a) (b) or (c) above.

8.06. Application of the recommendations set out in paragraph 8.05 is discussed in paragraphs 14.07 to 14.09.

Figure 5
Pressurised installations

Whole Installation Protection

Alternatives A or B permissible



A. with a Check Valve
near the Main (Para 8.03a)

B. No Check Valve
(Para 8.03b)

c

9

Protection of water used in industry

General

9.01. For lack of a more precise alternative, we define water used in industry as any use of water not specifically dealt with in other sections of our report. Therefore it may embrace non-domestic use in such diverse establishments as a factory, commercial and semi-commercial premises, garages, public swimming baths and laundries in large hospitals. This definition may prove to be too wide, and we consider that it should be continually reviewed as part of the work dealt with in Chapter 15. The general principles set out below should be a guide to making future decisions.

Present Position

9.02. In view of the range of size, nature, and complexity of industrial installations, it has not been possible to obtain a detailed and comprehensive survey of water use in industry similar to that carried out for domestic installations (see Chapter 3). It was clear from the results of the replies received to our questionnaire sent to water undertakers, and from further information which we received that the contamination of mains following an incident of backsiphonage in an industrial installation, could constitute a major hazard deserving special consideration. A modest survey was carried out to identify qualitatively the likely exposure of drinking water to contamination arising from backsiphonage within the industrial establishment and to assess the attitude of industry to the problem. Five factories varying in size and type of product were visited. It proved difficult to classify the methods by which water was distributed, but a typical system was one in which the process water was drawn by gravity flow from a large process water storage cistern which incorporated an air gap. Water used for drinking and other domestic purposes was taken direct from the supply pipe upstream of the process water storage cistern.

In two of the factories, an attempt had been made to distinguish between drinking water and process water by colour coding the pipes. In the other three factories process water and mains fed water pipes were less easily distinguished and the dangers to health resulting from cross connections and backsiphonage were not clearly understood by the maintenance staff.

The survey was too limited to enable us to draw conclusions about the awareness of industry as a whole to the dangers to health which may result from backsiphonage. However, we are able to draw on the extensive experience of some of our members and we have also had discussions with industrialists and statutory water undertakers. We have had no difficulty in determining minimum precautions, to prevent contamination not only of water in mains but also water used for drinking and other domestic purposes in industrial establishments. Water is used for industrial purposes in a large number of different ways in works varying in size from complexes covering many acres to small garages and laundries. To cope with this wide range there is a need for clear and simple recommendations which do not commit the enforcing authority to an onerous burden of inspection yet do not cause excessive expenditure to the industrial consumer.

Recommendations

9.03. Inspection and enforcement are essential features of any satisfactory system of precautions against backsiphonage. The following precautions are complemented by the enforcement recommended in Chapter 14. Table 9.1 summarises the requirements of (a) and (b) below:

(a) Water drawn from industrial, trade and commercial installations for domestic use in dwellings, lavatories, offices canteens, outlets marked 'drinking water', and vending machines, should be taken from drinking water quality supply pipes which are directly connected to the mains. Precautions which should be taken to protect the appliances and installations carrying water for drinking and other domestic use should be at least as stringent as those recommended in Chapters 7 and 8, where applicable.

(b) Water supplied by a water undertaker for use other than in (a) above and for fire fighting purposes (see (e) below) and used within any industrial establishment, should only be taken to either (i) an approved break pressure cistern with Class 1 protection or (ii) through a Type A air gap built into an appliance and so designed that water could be fed into it only at that point.

(c) No drinking water supply should be taken from a break pressure cistern described in b(i) above or from any connected process water distributing pipe. Process water pipes should be made readily distinguishable from pipes which convey water of drinking quality by colour coding the respective lines.

(d) There should be no cross-connection between any supply pipe and any pipe containing water from any other source.

(e) All fire fighting water draw-off points, and fire

Table 9.1

Protection of water in industrial, trade and commercial installations

Source of risk	Recommended suitable protection
Within canteens, restaurants, hotels, multi-storey office blocks etc.	Whole installation protection (see Chapter 8) in addition to protection at each point of use (see Chapter 7)
Humidifier (spray jets)	Type B air gap
Automatic drink vending machine	Combination anti-vacuum and check valve built-in to the machine.
Hose tap connectors (with a hose connected)	Class 1 protection either by gravity flow from a cistern in accordance with App. 5 incorporating a Class 2 device on the inlet or, if boosted, from a cistern incorporating a Type A air gap at the inlet.
Water in a process feed cistern (from which water is drawn for use)	1. where cistern complies with App. 5 and flow is by gravity at all times: Class 2 device on the cistern inlet. 2. in all other cases, Type A air gap at the cistern inlet.
Water in an industrial appliance (including mobile appliances, gully emptiers and the like) fed in directly from the main or supply pipe.	Type A air gap built into the appliance in such a way that water can be fed in only at this inlet.

mains (where such are specifically reserved for the purpose) should be clearly marked and identifiable. Only fire fighting equipment should be connected to these points.

(f) The occupier of an industrial establishment should be required to be able at any reasonable time to demonstrate to the satisfaction of the enforcing authority that no cross-connections exist between the various supplies noted at (c) and (d).

(g) The water undertaker should, at his own cost, take any additional precautions he deems to be necessary at the points of connection of the mains to high risk industrial installations.

Effect of recommendations

9.04. Our recommendations would require no more than good current industrial practice in which pipes carrying drinking water are clearly distinguished and are completely isolated by break pressure cisterns, or Type A air gaps, from industrial draw-offs and from any other pipes or installations within a factory. The protection recommended in most cases is Class 1. We have no doubt that installations in many industrial establishments already conform to a considerable extent although air gaps may only be Type B in many cases. There may be many small establishments where process water is obtained by means of hoses attached to drinking water taps and this situation should be remedied as soon as possible. Because some industrial establishments deal with processes which involve highly toxic substances water undertakers may decide that where the dangers are considerable it is necessary to install additional devices to protect the water in the public mains.

These measures will place an increased burden of inspection on the enforcing authorities but we have no doubt that the benefit in terms of reduced risk to health would fully justify the cost.

10

Protection of water used in hospitals

General

10.01. This chapter is in two parts, the first is concerned with hospitals within the National Health Service. The second part is concerned with other hospitals, whether publicly or privately owned and with establishments where medical and dental equipment is used outside hospitals in premises such as nursing homes, health centres, medical and dental surgeries, and in private homes.

10.02. Hospitals and medical premises have been identified at paragraph 4.05 as involving Class 1 risks. Within these establishments, water use ranges over the whole spectrum from domestic use by patients and staff, to specialised use in operating theatres and pathology laboratories and in equipment such as bed pan washers and haemodialysis machines. In addition, many uses may be classed as industrial, such as in centralised laundries.

10.03. The Department of Health and Social Security (DHSS) with which we have had consultations, is represented on the committee and members of our committee have inspected water installations, both in new and old National Health Service hospitals.

Hospitals have grown and developed over many years and their water installations are often the result of continual extension, alteration and reconstruction. The way in which supplies of water are drawn from mains and distributed within hospital precincts has in the past been dealt with locally between the undertaker concerned and the local hospital authority.

New National Health Service Hospitals

10.04. The National Health Service New Hospitals Programme envisage design schemes for new hospitals whereby standardised building blocks may be put together in various ways. Standard water installations have been designed for use in these blocks. Wherever practicable, the following design practices will be incorporated in new and altered installations:

(a) The incoming water supply will be led under pressure to cold potable water storage cisterns at roof level and of total capacity sufficient to meet a full day's demand. Where pressure is insufficient, ground level break pressure storage cisterns (capacity 16 hours' demand) will be provided in conjunction with booster pumps delivering to roof level storage cisterns (capacity 8 hours' demand). Cisterns will be provided with Type B air gaps on the inlets.

(b) Roof storage cisterns will be located and arranged for gravity feed to connected fittings and appliances (except for particularly hazardous situations (see (d) below)). Generally there will be two types of roof storage cisterns:

(i) Adequately protected and covered cold potable water cisterns used to supply drinking water points, sanitary fittings and other equipment in general hospital use will meet the following requirements:

—vessels will be closed having tightly fitting access covers bolted or screwed in position;

—where necessary, suitable linings or coatings will be provided to preserve the potability of the water;

—air inlets will be fitted with suitable filters;

—where necessary insulation will be provided against heat.

(ii) Feed cisterns intended for the supply of water to hot water supply installations.

(c) In hard water districts, a water softening plant would be interposed to treat water used in the hot water supply system and the laundries.

(d) In particularly hazardous situations within hospitals, such as in pathology laboratories, cold water derived from the roof storage cisterns will only be supplied through Class 1 protection.

(e) Wherever appropriate, suitably protected vent pipes will be provided to permit the ingress of air to the hot and cold water systems to eliminate the possibility of backflow occurring between appliances which are located at different levels in multi-storey buildings. Appliances will be 'down fed' from the ceiling, wherever practicable. Bidets and other appliances presenting similar risks will be supplied through separate cisterns and a single cistern with an air gap will be provided for facilities such as grouped haemodialysis units, provided the machines are on the same level as each other.

(f) Where possible, the water supply for sprinkler installations will be drawn directly from the supply pipe. Where insufficient water pressure is available, special arrangements will be necessary to boost the supply to the sprinkler system.

10.05. We would expect that within National Health Service Hospitals the hospital authorities will ensure that precautions against backsiphonage are maintained and that checks are made on the quality of the water in the installations.

Other hospitals and medical establishments

10.06. In addition to National Health Service

hospitals, there are other hospitals which are either publicly or privately owned and large numbers of smaller medical establishments such as private nursing homes, health centres and dental surgeries. These establishments contain a wide variety of installations and the supply arrangements will differ from one to another. Nevertheless, the principles of protection set out below and in chapter 6 should be made to apply to the whole installation and each appliance should be protected according to the class of risk.

Recommendations

10.07. These recommendations apply to all hospitals and other medical and dental establishments be they National Health Service, publicly or privately owned. Such establishments are premises where a high degree of protection should be afforded not only to the water in the water undertakers' mains but also within the installations to protect patients and staff. In addition to protection against backsiphonage being afforded at every point of use (as recommended in Chapter 7) whole installation protection should be provided (as recommended in Chapter 8).

10.08. Departments within hospitals and other medical and dental establishments which incorporate particularly hazardous situations, such as pathology laboratories, should have installations which can readily be separated from the general water distribution system within the premises by means of Class 1 devices through which water passes to serve each hazardous area. Drinking water supplies should not be taken from installations so protected, and special measures should be taken to provide a separate and safe supply.

Whilst we have not been able to recommend that bidets with fixed sprays in their bases and bidets with hand held sprays should be permitted for use in the home (see paragraph 7.11), we recommend that these appliances should be permitted for use in hospitals and other medical establishments. Both the hot and cold water supplies to these appliances should be separated from the general water distribution system within the premises by means of Class 1 devices.

10.09. Where hospitals and other similar establishments incorporate their own centralised laundry, hot water boiler and heating system or a water softening plant, each of these activities should be considered to be industrial use of water. Water for such purposes should first pass through a Class 1 device.

10.10. Particular care should be paid to each case where pumping is involved. It is preferable that a pump suction cistern fitted with a Type A air gap on the inflow should be provided in each case. Such a break cistern should be mandatory where the pumped water is used in such a way as to produce a Class 1 risk situation.

10.11. The water undertaker should take any additional precautions he deems to be necessary at the points of connection of the mains to existing hospitals and other medical establishments to protect the public mains.

10.12. Following the publication of this report, existing hospitals, both National Health Service and other publicly owned hospitals, should be inspected by their governing authorities to ascertain to what extent the installations comply or depart from our recommendations. Further, local Public Health Departments should consult water undertakers and the owners of private hospitals and other establishments where medical and dental equipment may be used, with a view to ensuring that our recommendations are implemented.

10.13. The risks from the use of water at hospitals and other similar establishments are self evident and our recommendations should be made to apply to all existing installations at an early date. Each establishment should be inspected regularly by the water undertaker to ensure that the water in the public mains is effectively protected.

10.14. The recommendations in paragraphs 10.07 to 10.10 are summarised at Table 10.1.

Table 10.1

Protection of water in hospitals and other medical and dental establishments

Source of risk	Recommended suitable protection
Hospital premises generally	Whole installation protection (see Chapter 8)
Points of domestic use	Protection at each point of use (see Chapter 7)
Particularly hazardous situations	Class 1 protection (local to the hazard) afforded by a break pressure cistern in accordance with App. 5.
Centralised laundry, hot water boiler and central heating plant, water softening plant.	Class 1 protection (as above)
Other uses which may be termed industrial or commercial.	See Chapter 9.

Protection of water used in ports, Docks and harbours

General

11.01. With the help of the Docks and Harbours Authorities Association and the authorities of individual ports, we have accumulated a considerable volume of information about the present arrangements for the supply of water in docks, harbours, fitting out basins and ship repair yards.

Twenty-one port authorities replied to a questionnaire and members of the committee have visited a number of the larger ports. With the help of the Department of Trade and Industry we have obtained information about conditions in some foreign ports.

Water supplies to ports

11.02. In some ports, the statutory water undertaker owns and operates the water distribution system. In others, supplies are afforded in bulk to the port authority who is then responsible within the port area for the distribution and supply of water to ships and other users.

Some port authorities in the latter category take supplies from the water undertaker into break pressure cisterns thereby reducing the risk of contamination entering the water undertakers' mains.

We have considered whether it is necessary for all supplies to port, dock and harbour mains systems to be afforded similar protection. However, in many ports there are large numbers of metered and other connections. Not only would break pressure storage cisterns be expensive, but the consequent loss of pressure might put port authorities to considerable difficulty. We consider that satisfactory protection can be given to water users in general, and to those users within a port area, without the necessity for the provision of such protection unless cold water storage cisterns have to be provided for other reasons and suitable air gap protection can be provided at low cost.

Arrangements on board ship

11.03. Generally, fresh water tanks are located in the lower parts of vessels. These tanks are usually filled by 'free fall' arrangement through flexible hoses which are connected to shore hydrants. The free end of a hose is dropped into a standpipe which connects an upper deck to the fresh water tanks. Pumps draw water from these tanks and deliver into a system of fresh water mains throughout the ship. The water is sometimes refiltered and chlorinated; an elevated storage tank is often situated in the superstructure of the vessel.

In addition, separate pumps draw water from the sea alongside the ship for delivery into systems of fire and deckwashing mains. The deckwashing mains should not, and normally do not, cross connect with the fresh water mains. It is common practice to keep fire mains drained. Along the fire mains there are usually several capped hose connection points and these can be connected, by hose, to shore appliances, including fire hydrants.

Potential backsiphonage situations

11.04. There are considerable local variations but we distinguish between the following situations that may arise:

(a) At berths and quays where a ship is always afloat: The ship's fire pumps remain primed with sea water and the only water required from shore is for the replenishment of the fresh water tanks. This presents few problems because filling is from the open end of a flexible hose which cannot become submerged in the ship's drinking water tanks. Nevertheless, the open end of the hose itself might become contaminated and precautions should be taken to avoid this happening.

There are occasions when the fire pumps of ships may be out of action, for example, when the ship is being fumigated. On these occasions, there may be need for connection of the ship's fire main to shore fire hydrants. Advance warning of this can usually be given.

We have been told that in the event of a serious fire, beyond the capacity of a ship's internal fire fighting system, the shore fire fighting services would not need to make direct connection to the ship's fire system.

(b) At dry docks and fitting out basins where either the ship's pumps cannot draw sea water from alongside or the pumps have been dismantled, fire hazards are considerable. It is common practice for direct connections to be made and maintained between the shore hydrants and the ship's fire mains, deck washing mains and sprinkler systems. If operable, a ship's fire pumps could be started up while the shore connections were in place. In the event of this happening, a potentially dangerous situation could arise whereby contamination might gain entry both to the port's mains and possibly the water undertaker's mains.

A supply of water is sometimes required from shore to ships under repair and fitting out for the following purposes:

(i) filling of ship's tanks for calibration or pressure testing;

(ii) cleaning of tanks and bilges;

(iii) providing temporary cooling water supplies to

auxiliary machinery undergoing post repair trials.

(c) At certain car ferry terminals, direct pressurised connections are afforded between the shore and the ship's fresh water system. This is to assist the quick turn-round of ships. Such arrangements may also exist at other categories of termini.

(d) Fire risks at an oil terminal are exceptionally high and large volumes of water may be required quickly. Pressurised connections between an oil tanker's fire fighting mains and the shore are the rule rather than the exception. However, it is usual for water storage to be provided because oil companies cannot rely on adequate mains water supplies being readily available from the water undertaker. Usually, air gaps can be provided at the inlet to any storage tank.

(e) Some docks and fitting out basins have separate systems of fire fighting mains carrying non-potable water and direct connections can be made between ship and shore. There is a risk that cross-connections may occur between such mains and drinking water mains.

(f) Most of the larger, and some of the smaller ports contain industrial and commercial establishments in which water is used and these premises should be dealt with according to the principles set out in Chapter 9.

(g) At marinas and small boat berths, water supplies to yachts and motor cruisers are usually afforded from shore standpipes. Standpipes are often equipped with permanently attached hoses and instances have been reported where the free ends of hoses have been left lying in contaminated water.

International Ship-Shore Connector

11.05. Most ships and ports carry internationally agreed flanged couplings which enable any ship so equipped to make direct connections between its fire mains and shore hydrants. We have consulted the Home Office and other authorities concerning the implications of the use of this coupling. Making direct connection to drinking water mains using this coupling would be contrary to our recommendations. Enquiries have led us to believe that the connector is rarely used in the United Kingdom, and little or no inconvenience would be experienced if it is not used in this way.

Recommendations

11.06. The following recommendations deal with only those situations which are peculiar to ports, docks and marinas:

(a) All dockside hydrants and other fittings connected to or which form part of drinking water systems should be clearly marked by internationally agreed signs and with the words 'Drinking Water'. All dockside hydrants and other fittings connected to non-potable supplies should be clearly marked by internationally agreed signs and with the words 'Not Drinking Water'.

(b) The outlet end of every hose or other flexible pipe used for supplying drinking water from shore mains to a ship should be so constructed that it will ensure a 'free fall' gravity flow delivery. An effective Type A air gap should be maintained at all times between any ship's installation and the shore drinking water mains. Except as described in the next sub-paragraph, pipes for shore drinking water mains should not be positively connected to any pipe on a ship.

(c) Water from shore required 'under pressure' on board ship should only be supplied in one of the following ways:

(i) If by direct connection, only from a separate non-potable main.

(ii) From a storage cistern in the port area situated at sufficient elevation to provide the required flow by gravity. No drinking water installation on shore should be connected to a main which conveys water under pressure from a storage cistern for direct connection to a ship. Supply from the drinking water main into the storage cistern should only be made through a Class 1 device.

(iii) From a suitable mobile or fixed storage cistern at ground level used in conjunction with an automatic booster pump installation. Supply from the drinking water main to such a cistern should only be made through a Type A air gap.

(d) The only hoses and flexible pipes which should be permitted for use should be those kept for the purpose by the water undertaker or the Port Authority. All hoses and other flexible pipes used for conveying drinking water to ships should be kept clean and when not in use should be properly protected, stored and transported in vehicles or other containers reserved especially for the purpose.

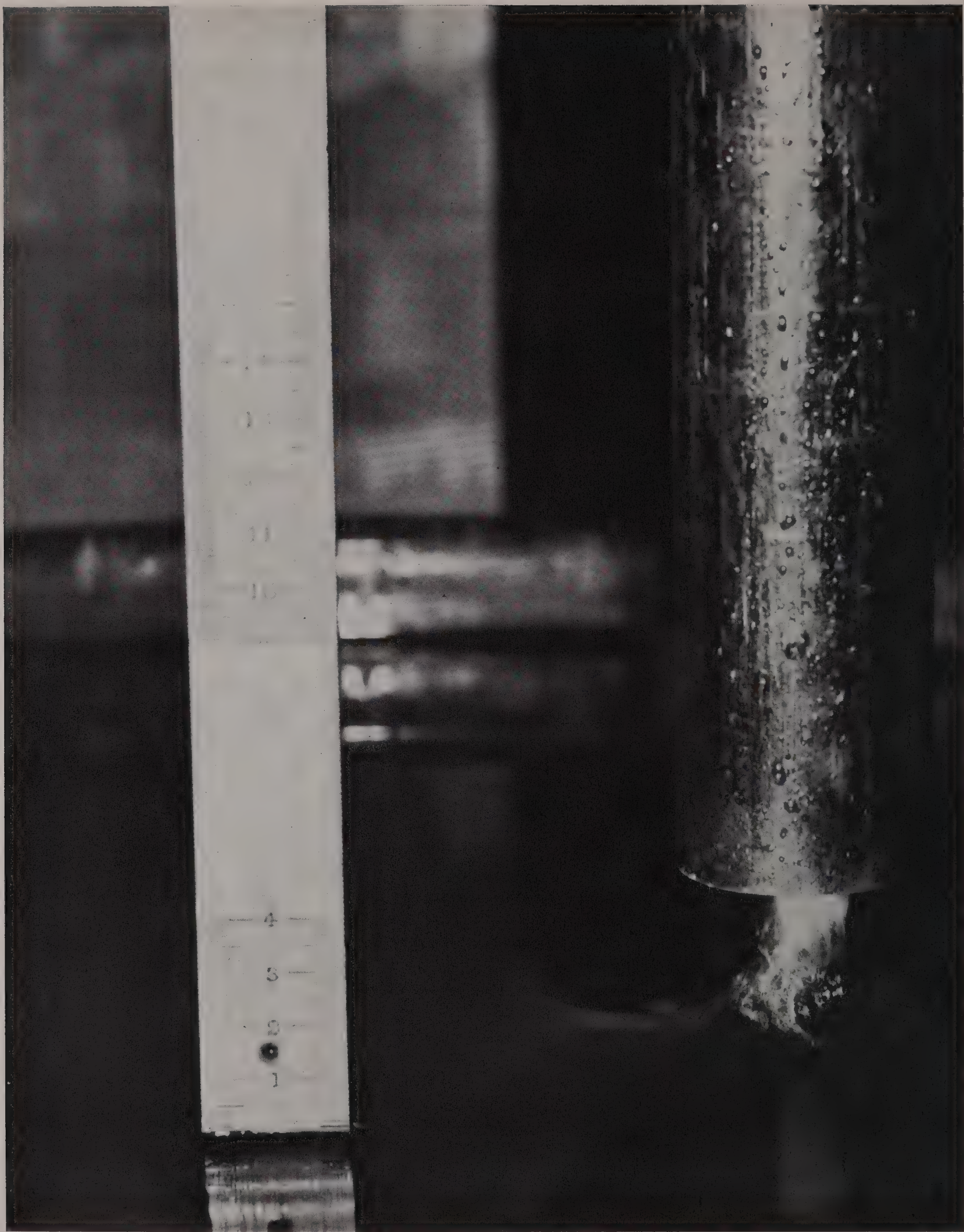
(e) At berths where both drinking water and non-potable water supply points are necessary the drinking water supply points should be kept to the minimum in number and, as far as practicable, they should be segregated from the fire fighting water supply points.

(f) At marinas and wharves where small boats obtain drinking water supplies, every standpipe and fitting to which a hose could be connected should incorporate an approved check valve and an anti-vacuum valve in combination. When the hose to be connected is larger than 18mm diameter, the anti-vacuum valve should be located at an elevation which is at least one metre above the deck level of the largest boat likely to obtain supplies from the installation. When the hose is 18mm or less in diameter, precautions appropriate for domestic hose fittings (Table 7.2) may be applied.

Effect of recommendations

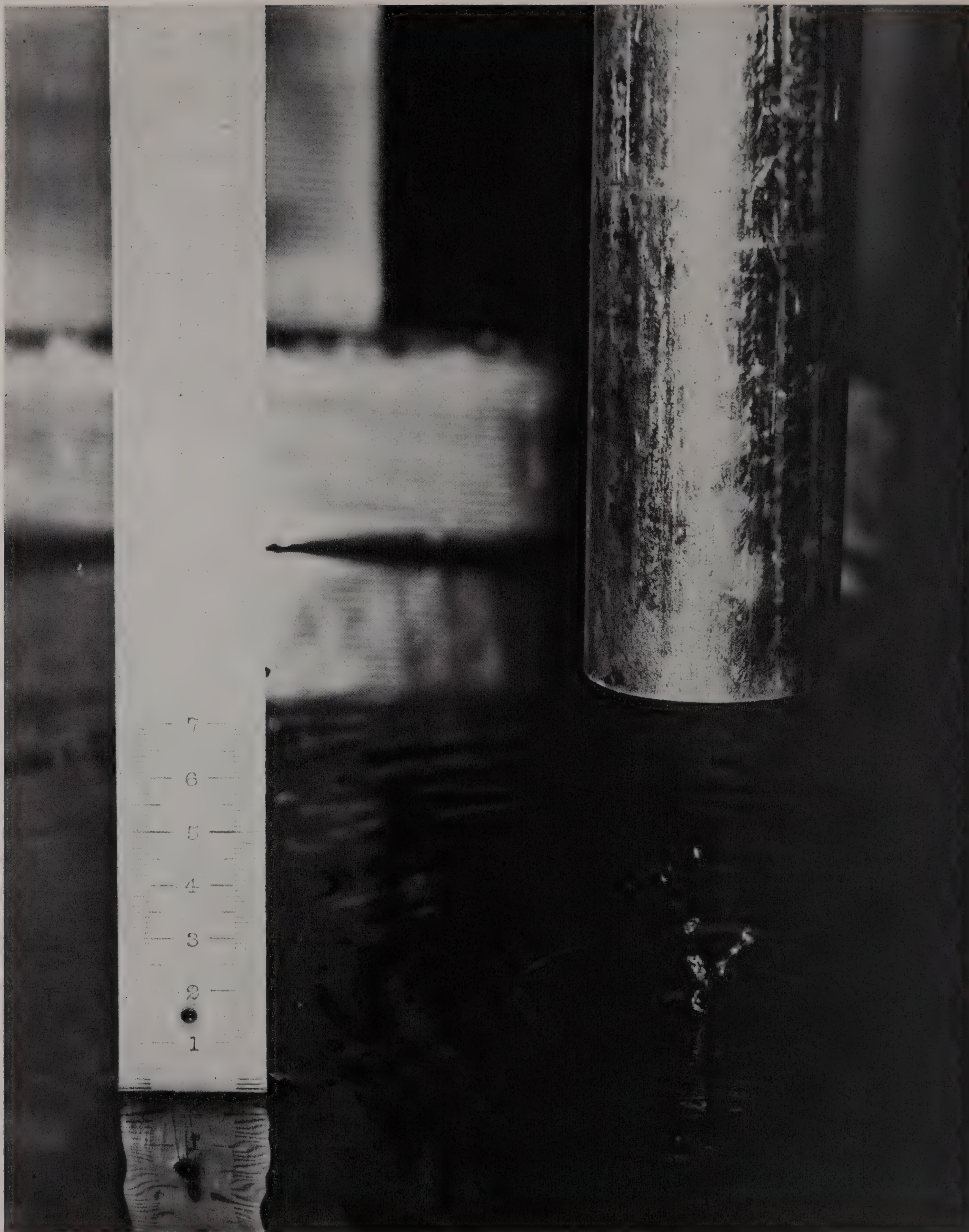
11.07. As far as we can determine, the effect of our recommendations on installation in docks, quays and in harbours will be minimal. Current practice does not seem to give rise to many problems. The situation is quite different, however, in dry docks and fitting out basins. At some docks inspected by our members, relatively simple and inexpensive measures would suffice to bring the installation into line. There may be others where considerable expense might be involved. We recommend that this section of the report be brought to the attention of port authorities.

1 Vacuum tanker and test rig on 40 mm bore pipe

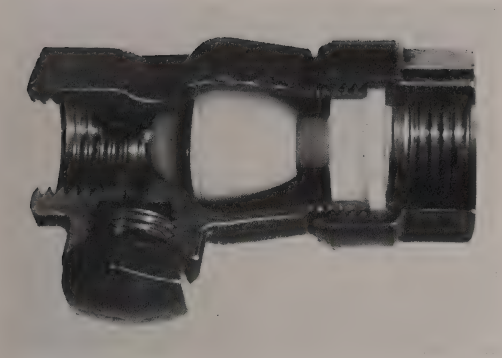


2 40 mm air gap – backflow taking place

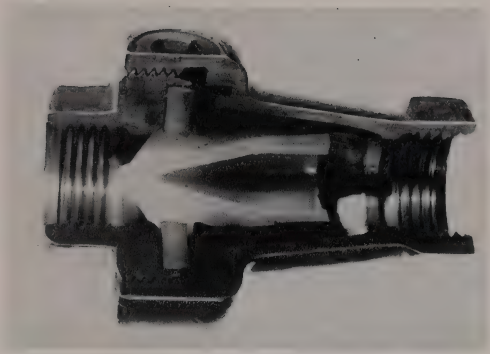
3 50 mm air gap – limited backflow



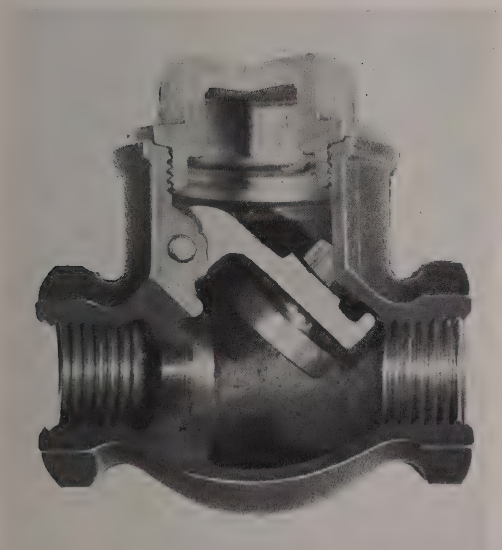
4 70 mm air gap – no backflow



5 German check valve

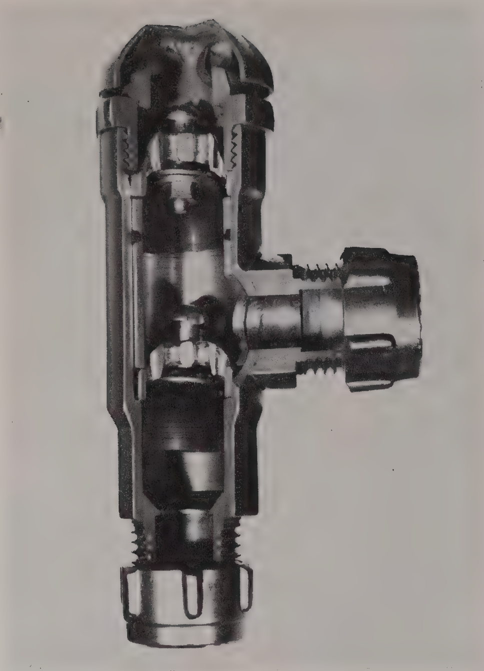


6 German check valve

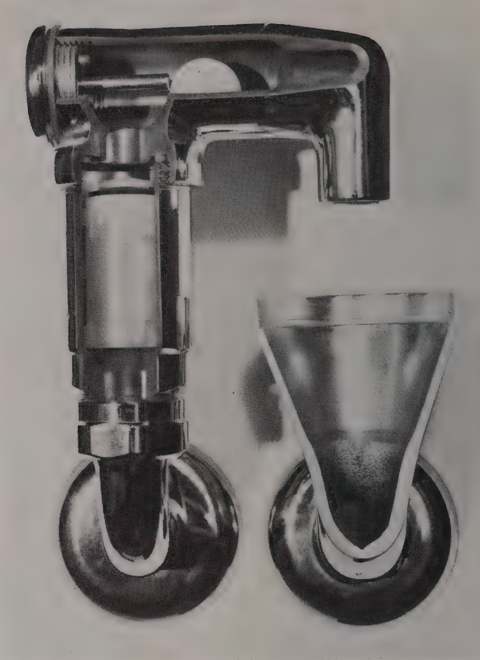


7 British check valve

8 German check/anti- vacuum hose tap

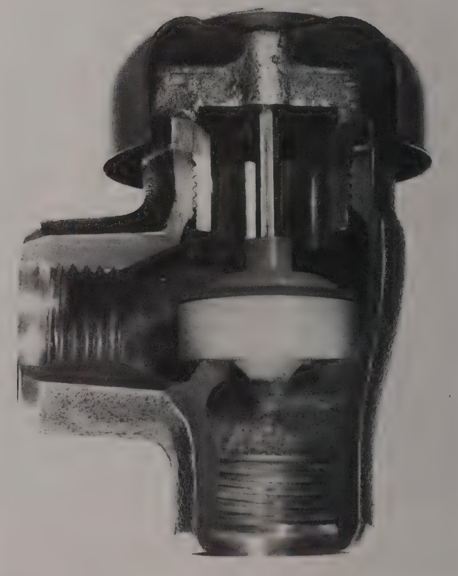


9 British check/anti-vacuum valve

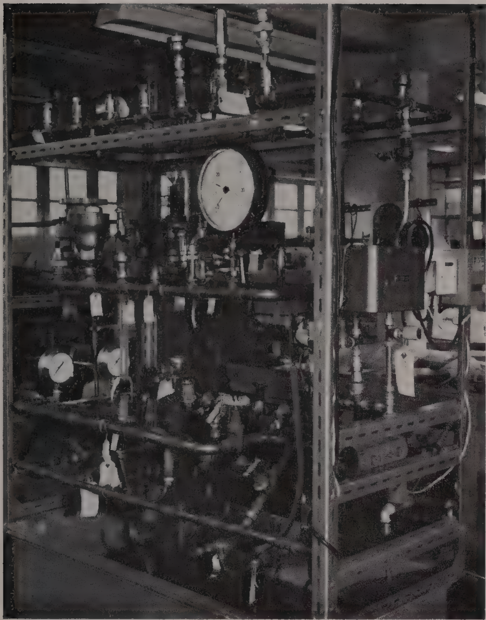


10 German terminal anti vacuum valve

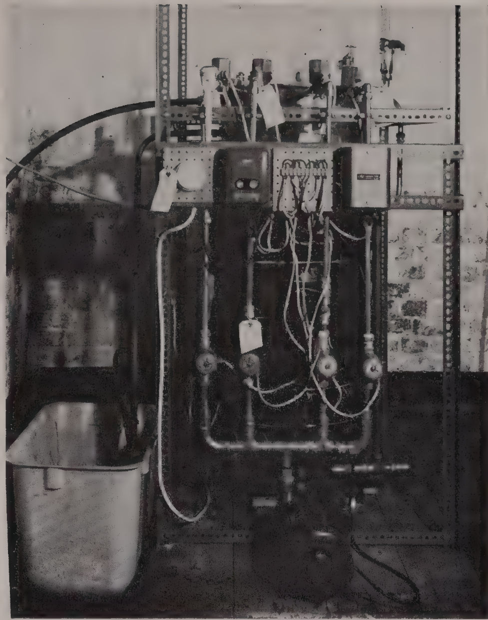
11 American pipe interrupter



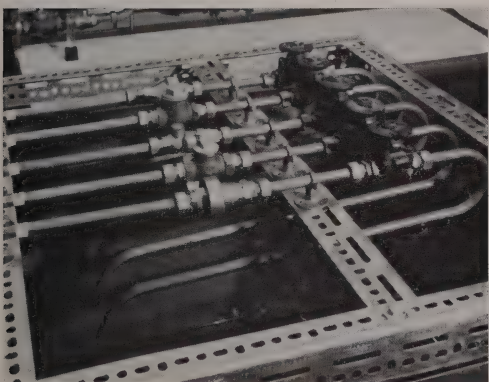
12 American anti-vacuum valve



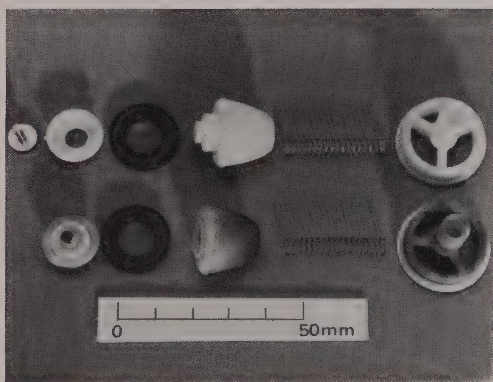
13 Wear test at British Waterworks Association test station



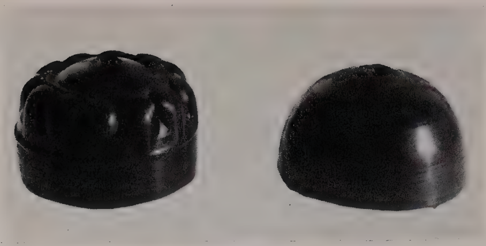
14 Scale deposition rig at West Drayton Pumping Station



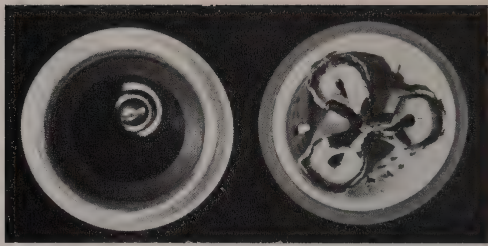
15 Sand Erosion Test at Building Research



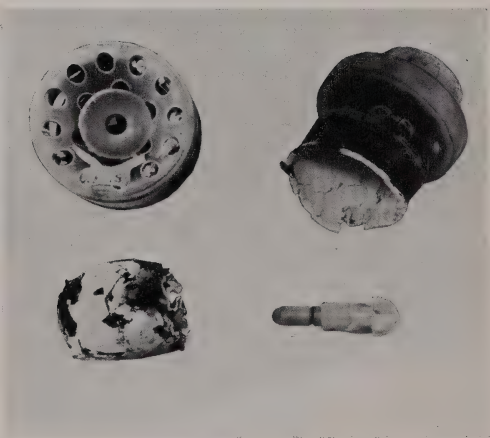
16 Material failure after prolonged pressure and temperature test



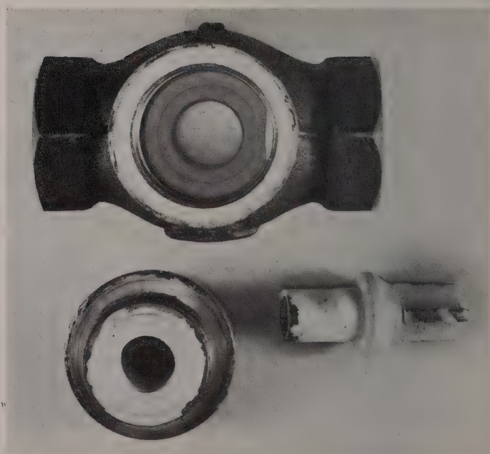
17 Material failure after prolonged pressure and temperature test



18 Failure of check valve during scale test



19 Failure of check valve during scale test



20 Scale build up on check valve

Protection of water used in agriculture

Present Position

12.01. There are at present only a few byelaws which specifically apply to agricultural and horticultural water installations but the general requirement of air gap protection applies to almost all the appliances and installations which are used. Not all farms receive mains supplies and this part of the report obviously applies to those that do. Mechanisation and the application of science is increasing in these industries. New and complex chemicals such as pesticides and herbicides are being continually developed. Many of these are potentially harmful to health even when present in water in low concentrations. New designs of machines using water for mixing, diluting, transporting and applying chemicals are also being produced. Mains water is often used under pressure as a source of power for mixing chemicals and for other purposes; consequently potentially hazardous situations could arise.

The provision of piped water about the farm, to fields (principally for livestock watering), and to horticultural and other holdings (for irrigation) is now normal practice and grants are given for this purpose. According to figures published by the Ministry of Agriculture, Fisheries and Food, as many as 3,000 schemes for new water installations in farms and market gardens are submitted each year to the Ministry for grant.

Need for special precautions

12.02. The results of the survey published in our Progress Statement show that there is reason for concern about agricultural and horticultural water use. Hazards arise from the use of hoses which are attached to standpipes; free ends of hoses may be attached to machines and vessels containing dangerous chemicals or they may be left lying in pools of heavily polluted water.

Watering points for livestock are another potential source of contamination. Watering troughs, other than presently approved types, are used and these often have air gap protection which relies on overflows liable to blockage. Many farms have some private water supply, often of doubtful quality. When a mains water supply has been installed, the private supply has not always been disconnected. Cross connections between the private supply and the mains supply within the plumbing installation are potential risks to health. It may be difficult to discover whether cross connections have been made.

These potential backsiphonage situations are similar in many ways to those which have been identified as likely to occur in industry. Installations are numerous and widespread and consequently enforcement of precautions may be difficult.

Recommendations

12.03.

(a) Water derived from the public mains for human consumption, that is for drinking and other domestic uses in farm houses, cottages and farm and horticultural buildings should only be taken from supply pipes which are directly connected to the public mains. Precautions to protect the appliances and installations carrying water for drinking and other domestic use should be those recommended in Chapter 7.

(b) Water supplied by a water undertaker for other use within any agricultural or horticultural premises, should only be drawn from drinking water quality pipes which serve farm houses or cottages or directly from the public mains in any of the following ways:

(i) into a break pressure cistern through a Class 2 device, provided that in each case the cistern is at sufficiently high elevation to afford gravity flow to each point of use and no appliances such as booster pumps are connected, or water from other sources, which may cause back-flow into the cistern. If back-flow can take place into the cistern for any reason, then the cistern must be fed through a Type A air gap.

(ii) into livestock watering troughs through shrouded Type A air gaps

(iii) into an appliance directly; through a Type A air gap built into an inlet of the appliance itself and so designed that water can be fed into it only at this point.

(c) No drinking water supply for human consumption should be taken from any one of the cisterns in (b) above or from any connected distributing pipes.

(d) No drinking water supply for human consumption should be cross-connected to any of the cisterns in (b) above or to pipes containing water from any other source.

(e) The occupier of an agricultural or horticultural premises should be required at any reasonable time to be able to demonstrate that no cross connections exist between the various supplies on the premises.

12.04. Recommendations (a) and (b) above are summarised in Table 12.1.

Table 12.1

Protection of water in agricultural and horticultural premises

Source of risk	Recommended suitable protection
Points of domestic use of water in farm houses, cottages, farm and horticultural buildings.	Protection at each point of use (see Chapter 7)
Water in a break pressure cistern from which water is drawn for use by gravity only.	Where the cistern complies with App. 5: Class 2 device on the cistern inlet.
Water in a break pressure cistern serving booster pumps or into which water may enter from other sources.	Type A air gap at the inlet to each cistern.
Water in a livestock watering trough.	Approved watering trough incorporating a Type A air gap at the inlet.
Water in an appliance supplied directly from a main or supply pipe.	Type A air gap built into the appliance in such a way that water can be fed in only at this inlet.
Hose tap connectors (with a hose attached).	Class 1 protection afforded by a break pressure cistern in accordance with App. 5.

Effect of recommendations

12.05. The recommendations are unlikely to affect domestic installations in farms and small holdings to any material degree. Nor would they prohibit the supply of water direct from public mains to approved designs of watering troughs (that is, troughs which incorporate Type A air gaps). Our principal concern has been to guard the public mains against contamination arising from the use of standpipes and other draw off points to which hoses could be attached.

12.06. Standpipes fitted with hose connections are commonly connected to the mains or supply pipes to enable water to be drawn for use under mains pressure. We have considered whether an exemption could be made to our recommendation at 12.03 (b)(iii) providing the standpipe were protected by means of a combination anti-vacuum and check valve. However, we are convinced that the risks from the use of water taken this way in a farm or market garden are such that we cannot recommend a lower category of protection than a Type A air gap. Therefore our recommendations would have important and highly desirable consequences for the design and manufacture of water using agricultural equipment in future.

13

Installation cost implications

General

13.01. Our aim has been to rationalise precautions against backsiphonage. We consider some existing precautions need strengthening, others are unduly restrictive. In this chapter, we attempt to balance the consequential increases and reductions in cost of implementing our recommendations against each other, almost entirely with respect to domestic properties. We have been unable to make any detailed assessment of the cost implications elsewhere (but see paragraph 13.13).

13.02. One of the consequences of implementing our recommendations would be to give designers and installers greater flexibility of choice and opportunity for economy. In many cases, total installation costs could be significantly less but we have no way of quantifying such savings and have not allowed for them in this chapter.

13.03. There is such a wide variety of installation, varying from fully stored to fully pressurised, from installations in single dwellings to those serving large blocks of flats, from dwellings with few appliances to those with many that we cannot attempt to estimate savings or added costs for the country as a whole. Nevertheless, some guidance must be attempted and our approach has been to examine a range of installations and to look at the cost of protecting typical examples.

13.04. The remainder of this chapter is divided into two parts. The first part deals with costs of protection at the point of use. The second part deals with the added cost of providing whole installation protection. A consequence of the implementation of our recommendations will no doubt be an increase in the cost of inspection. These costs have not been considered in this chapter but are discussed in paragraph 14.06.
All costs given in this chapter are based on 1973 figures.

Protection at the point of use

13.05. *New Dwellings*

(a) Dwellings with stored installations (see paragraph 7.07)
Any hose connection on a pipe subject to mains pressure would be required to be equipped with a combined anti-vacuum and check valve, at an additional materials cost of the order of £2.00 per tap. On the other hand a single outlet type combination tap assembly would be permitted at the kitchen sink in place of the more expensive double outlet type which is currently the only permitted hot and cold water mixing unit.

(b) Dwellings with unbalanced installations (see paragraph 7.08)
In addition to protection of any hose connection (as in a above) and the ability to use a single outlet type combination tap assembly at the kitchen sink, mixing valves would be permitted for use with flexible shower fittings without the need for both hot and cold water to be taken from a storage cistern as at present.

(c) Dwellings with fully pressurised installations (see paragraph 7.09)
We have recommended that with suitable protection, fully pressurised installations could be permitted in the United Kingdom. The cost of protection against backsiphonage would form an integral part of the total installation costs. Designers would be free to determine whether there were any cost advantages in adopting the fully pressurised installation in any particular case, and it would be for them to consider the various advantages and disadvantages of alternative installations.

With the above factors in mind, we conclude that our recommendations for protection at the point of use in new dwellings would not increase the cost of construction and there will be considerable opportunities for savings by efficient design, manufacture and installation. Although we have little information on maintenance costs we consider the expenditure on maintenance should not be greatly affected.

13.06. *Existing dwellings*
Existing installations complying with the present byelaws would meet our recommendations if existing hose union taps were modified by fitting a suitable protective device. Nevertheless, the more frequent inspection we recommend in Chapter 14 would undoubtedly bring to light many instances where further modifications were necessary as a result of installations contravening existing byelaws.

Whole installation protection (see Chapter 8)

13.07. *Individual dwellings*
In our desk studies, costs were estimated for several examples of compact water installations each with and without whole installation protection. In all cases the same house plan was taken and stored, unbalanced and full pressurised water installations were considered in turn. The exercise was repeated to enable the effects of differing supply pressures to be considered.
It was established that in straightforward new

installations such as those examined the added cost of whole installation protection could be of the order of 10% of the basic cost of the installation (excluding appliances) and would not be significantly affected by service pressure.
We estimate that the added cost of labour and materials for whole installation protection for new single dwellings could be on average, of the order of £15.00. The cost of arranging pipework to facilitate its future introduction would be of the order of £5.00.

13.08. *Buildings in multi-occupancy* (such as flats)
Whole installation protection and protection at each point of use would enable:
(a) single outlet combination tap assemblies to be fitted at kitchen sinks in place of double outlet types, and mixer valves could be used elsewhere in the case of unbalanced systems.
(b) upstands could be built-in to the installation which would enable otherwise unprotected flexible shower fittings to be used.
(c) the whole installation would be protected generally.
The cost would be small when apportioned between the dwelling units served and a considerable increase in safety of the installations could be achieved together with a potential for saving in overall costs.

13.09. *Existing buildings in multi-occupancy*
A satisfactory level of whole installation protection could be achieved by providing anti-vacuum valves, vent pipes and check valves. Average costs of labour and materials in respect of existing flats could be of the order of £5.00 to £10.00 for each dwelling unit but we must emphasize that the actual cost would depend entirely on the individual circumstances.
13.10. We conclude that whole installation protection could be a significant factor in the cost of individual dwellings, but where grouped facilities for protection are feasible, the extra cost per dwelling unit falls sharply. However, there will be added costs associated with the regular maintenance of whole installation protection devices.

Industrial, commercial and agricultural installations
13.11. We have not attempted a costing exercise for these installations. The wide variety and complexity of these installations is such that only a generalised approach to costs is feasible. However, the precautions we propose are simple and cheap in principle. Many existing installations already conform to our recommendations and modifications would not be necessary. In the majority of other cases, modifications should be straightforward and would principally deal with the protection of drinking water pipes and connected appliances.

Hospital installations
13.12. We estimate that future hospital wards protected in accordance with our recommendations will involve an increase of about 1% of the total first cost of the pipework.
13.13. We have not attempted to estimate the cost of modifying installations in existing hospitals and other medical establishments to conform with our recommendations due to their wide variety and complexity. In some cases, cost could prove to be significant.

Conclusions
13.14. The adoption of our recommendations for protection at point of use in domestic installations will not lead to any overall increase in cost. On the contrary, we expect that the flexibility of prescription of devices appropriate to risk will be welcomed by experienced designers and in combination with the relaxations proposed, costs could be reduced significantly.
13.15. Whole installation protection could be a significant element in the cost of an individual dwelling but the related cost falls sharply if grouped facilities for protection can be arranged, as for example in a block of flats.
13.16. We can see no cause for concern that our recommendations will necessarily involve industrial, commercial and agricultural interests in unreasonable expense. We cannot visualise that significant expenditure is likely to be necessary except where existing installations have developed extensively in piecemeal fashion without complying with the present byelaws.

14

Enforcement

The present position

14.01. Enforcement of backsiphonage protection is an essential part of the enforcement of water byelaws generally. Byelaw 4 of the Model Water Byelaws (1966 Edition) grants an exemption for fittings which have been lawfully fitted. In effect, this byelaw provides that, except insofar as byelaw 7 (unserviceable fittings and fittings not mentioned in the byelaws), byelaw 10(4) (Protection from damage from frost) and byelaw 24 (Stop valves on pipes supplying buildings) apply, the byelaws shall not be deemed to be retrospective.

Notwithstanding the exemption provisions of byelaw 4, the more important aspects of the prevention of waste and contamination are safeguarded by byelaw 7. Should all the byelaws in the form in which they have evolved be made completely retrospective, the cost of modifying all existing installations at the same time could impose heavy financial burdens on many consumers.

14.02. There are large numbers of domestic, industrial and other premises in which fittings do not comply with the provisions of some of the Model Water Byelaws. In particular, it is a widespread experience that byelaw 59, (which requires a person carrying out alterations to water fittings to give notice of his intention to carry out such alterations) is largely ignored. We have considered whether observance of this byelaw would be encouraged by some form of registration of plumbers. Some EEC countries have mandatory systems for licensing of plumbers. Our Committee is not clear as to the implications for the United Kingdom particularly in view of possible requirements to remove barriers to free movement of labour with the EEC. There might be a need for the whole question to be examined separately and for this reason we recommend that a Working Group be formed, preferably following consultation with the National Water Council.

Frequency of inspection by the water undertaker

14.03. From the results of the surveys and investigations referred to in Chapter 3 it is evident that byelaws are contravened in many installations. Because of the risks involved we conclude that regular inspection of all installations is essential but inspection of industrial and other non-domestic establishments should be more frequent and intensive than inspection of installations in homes.

14.04. We recommend that the minimum frequency of inspection of installations by the undertaker should be determined on the following basis:

(1) Installations in homes
- (i) on completion of the installation and before its connection to the mains,
- (ii) on receipt of notice of alterations,
- (iii) on change of occupancy, and
- (iv) when contamination, leakage or other defect is being investigated.

(b) Industrial and other premises
- (i) as for dwellings, and
- (ii) not less frequently than once a year and more frequently according to the undertakers' assessment of the risk.

Extent of responsibility for enforcement

14.05. At present, the water undertaker has a statutory obligation to provide a wholesome water supply and to fulfill this he is concerned with all installations and appliances connected to his mains. In fulfilment of principle 1 in paragraph 6.01 he will be concerned with the use of water for drinking purposes within consumers premises.

In the enforcement of byelaws, it is particularly important that measures providing for quick and effective action should be taken to remedy situations involving, or likely to involve, serious contamination of the public mains. We consider that such measures should reinforce any power to disconnect the supply to a consumer whose installation is in the opinion of the water undertaker likely to cause contamination of the mains. As a further measure we consider that penalties for contraventions of the Water Act and byelaws in respect of offences which could lead to contamination should be reviewed.

14.06. The increasing sophistication and complexity of consumers' appliances and installations demand a corresponding improvement in the level of training and performance of inspection staff. It is a common practice for water undertakings to employ two categories of inspector, one being concerned with inspection and approval of installations and the other with waste inspection. However, the arrangements envisaged in the preceding paragraphs call for an inspection force trained to undertake both functions. In addition, it may be desirable to have more highly skilled staff for special duties such as the inspection of complex installations. While requirements would vary from district to district, a total byelaw inspection force on a scale of about one inspector per 25,000 population may be considered as reasonable, but this may be a matter for review following consideration of

paragraphs 14.04, 14.05 and 14.08 to 14.11. It is therefore not possible to estimate the increased costs associated with byelaw inspection until the extent of water undertakers' obligations in respect of our recommendations have been settled.

Application of the report's recommendations

14.07. We have considered what action should be taken to inspect and modify those installations which are at present exempted from the application of a number of the present byelaws. The survey of backsiphonage risks in domestic properties (referred to in Chapter 3) indicated that the proportion of properties at a varying degree of risk increased with age as follows:

Less than 5 years old	36% at risk
Between 5 and 15 years old	63% ,, ,,
Greater than 15 years	84% ,, ,,

14.08. We realise that considerable expense would be involved were all our recommendations to be applied retrospectively to all existing installations. Nevertheless, the risks arising out of properties at present connected to public mains are considerable and we are agreed that ultimately all existing installations should be brought into line with the recommendations in this report. A compromise must be reached between excessive cost to consumers and undue delay in implementation; we make the following recommendation:

In the case of existing installations, a period of five years should be allowed for the responsible water authorities to carry out programmes of observation and inspection of installations in their areas. At the end of that period, the position should be reviewed to determine the need for retrospection. During the five year period special attention should be given to the following classes of installations:

(a) installations in premises where substantial numbers of people congregate such as large institutions;
(b) installations in industrial premises;
(c) installations in buildings of multi-occupancy, such as blocks of flats.

In the meantime, we identify specific cases where we consider our recommendations should apply forthwith (see paragraph 14.10).

14.09. We recommend that as soon as possible, *all new installations* should incorporate the appropriate recommendations made in this report including 'whole installation protection' where applicable under paragraph 8.05.

14.10. As far as *existing installations* are concerned, we propose that the appropriate recommendations made in this report should be applied forthwith to installations:

(a) where the water undertaker has reasonable grounds for believing the particular circumstances of the installation are such that contamination of drinking water is caused or is likely to be caused;
(b) when an installation is extensively modified or extended.

14.11. Water undertakers should first inspect the pressurised parts of existing installations (other than domestic installations in dwellings) as soon as possible to determine whether or not circumstances mentioned in paragraph 14.10 have arisen.

15

Continuing Work

Testing and evaluation of devices

15.01. Our recommendations have in part been based on an exhaustive series of tests of mechanical devices for the prevention of backsiphonage, but the work is not complete and will inevitably be of a continuing nature. An important feature in the appraisal of devices is their actual performance under service conditions. We envisage a series of tests in areas selected on the basis of the chemical characteristics of the water supplied. The results of such further tests would not be available for some considerable time after this report has been published.

We recommend that as new safety devices and measures are developed, series of tests similar to those carried out for us should be arranged and the results evaluated. Suitable laboratory facilities with skilled staff are essential.

This work should be part of a continuing national programme co-ordinated with the programmes of other member countries of the EEC in close collaboration with water undertakers and various organisations' representatives of consumers, designers, manufacturers and installers in the United Kingdom.

Assessment of future developments

15.02. As new water using appliances and plumbing installations are developed, new situations of potential backsiphonage may arise. We recommend that these should be evaluated and appropriate safety measures should be selected at an early date so that designers and manufacturers may incorporate them efficiently and effectively.

Any new requirements for safety measures should be speedily incorporated under appropriate legislation; it is most important that desirable developments should not be inhibited by uncertainty about statutory requirements.

There is a clear need for (a) a national advisory body in close touch with water undertakers, water consumers, manufacturers of fittings and appliances and designers and installers and (b) a flexible system of legislation, to enable recommendations to be put into effect uniformly and speedily. It will be increasingly necessary to take account of parallel evaluation and legislation and of developments within the EEC.

Type testing and approval

15.03. To ensure that appliances and fittings comply with legislation we recommend that they should be type tested and approved by a single national test institute which is authorised to do so on behalf of enforcing authorities and which is recognised by government. Whenever we refer in this report to an approved device or appliance, we mean one approved by such an institute.

The BWA Standing Committee on Water Regulations has done stalwart work for many years. With the co-operation of manufacturers of fittings, the Committee has in large measure succeeded in ensuring a high standard of compliance with the byelaws in mass produced equipment made in the United Kingdom. Nevertheless, water undertakers, and consequently the BWA Standing Committee have no powers to prevent the sale of appliances and fittings which have not been approved. Also it is not clearly understood by everyone, and in particular by manufacturers and installers, that approval is only in respect of compliance with present legislation concerning waste, misuse and contamination. Much of this latter difficulty would be removed if byelaws were expressed in clearer and in more direct terms.

Quality Control

15.04. Type testing and approval cannot by itself ensure that similar manufactured articles are equally reliable or that approved design features remain unaltered. Quality control and marking of safety devices should be mandatory. In order that standards are maintained in imported as well as home manufactured products, it is essential that agreement should be reached with recognised foreign certifying bodies for reciprocal approval and quality assurance arrangements for safety devices.

Interpretation

15.05. Only in recent years, after a succession of models have been issued, have byelaws become reasonably uniform in the United Kingdom.

There are still wide variations in local practice and attitudes are hard to change. Manufacturers and installers may be handicapped by variations of interpretation of apparently similar requirements by individual water undertakers.

Such difficulties could be overcome by a co-ordinated approach to legislation, organisation, education and training. In particular, there is a need for a speedy and efficient national system to mediate in disputes between manufacturers (or installers) and the enforcing authority. Such a system is considered to be an essential feature of effective approval and enforcement work.

The national scheme

15.06. The Water Act 1973 provides for water supply to be the responsibility of ten regional water authorities. It will be the duty of the National Water Council to consult with statutory water companies in England and Wales, regional water boards and water development boards in Scotland, the Ministry of Development in Northern Ireland, the Greater London Council and associations of manufacturers, local authorities, trades unions and others with a view to establishing a scheme for the testing and approval of water fittings, thus ensuring the continuation of the work presently carried out by the BWA in applying standards and the testing of fittings and appliances. We welcome this and emphasise the need for the scheme to be truly representative so that uniformity of enforcement of legislation is obtained throughout the United Kingdom.

16

Summary of main recommendations

Protection of water in the home and domestic use elsewhere

16.01. Recommendations for protection of water in the home and domestic use elsewhere are based on protection at every point of use (Paragraph 7.01).
16.02. Silencing pipes used in association with ballvalves should be permitted providing suitable Class 2 protection is afforded (Paragraph 7.02).
16.03. All make-up water used in domestic boiler and central heating installations should be fed through a Type B air gap or equivalent (Paragraph 7.05).
16.04. Single outlet type combination tap assemblies should be permitted in stored and unbalanced installations providing suitable precautions are taken to prevent hot water flowing into the cold feed pipe (Paragraphs 7.07 and 7.08).
16.05. The cold feed to the secondary circuit of a heating apparatus may be taken direct from the supply pipe providing there is no cross-connection with the primary heating circuit and that the recommended precautions are taken at every point of use. This recommendation is qualified by a warning about safety requirements against explosion hazard (Paragraph 7.09).
16.06. Installations should be designed and equipped so as to deter or remove the need for unprotected temporary hose connections. Future relevant Codes of Practice should stress the need to locate one or more protected hose union taps in every house. A properly protected flexible shower appliance should be specified as a matter of course in new dwellings. The appropriate BS should be modified to specify that taps (other than properly protected hose taps) should be designed so as to make it difficult to fit hoses to them (Paragraph 7.10).
16.07. The over-rim fed type of bidet having shrouded Type A air gaps at the hot and cold water inlets should be the only permitted type. Bidets should be designed in such a way as to prevent the subsequent attachment of temporary hand held sprays (Paragraph 7.11).
16.08. In domestic installations, the covers of cold water storage cisterns should be rigid with overlapping edges and so designed that they cannot easily be dislodged. In all other cases where drinking water quality must be preserved the cistern should be adequately protected to meet Model Byelaw 9 requirements (Paragraph 7.12).
16.09. The recommended protection for most common domestic fittings and appliances are summarised in Tables 7.1, 7.2 and 7.3.

Whole installation protection

16.10. There are installations where the risks are multiplied either through internal circumstances, such as exceptionally heavy use of connected appliances, or to external circumstances, such as frequent low pressure conditions in the water mains. Whole installation protection, described in paragraphs 8.02 and 8.03, should be afforded in buildings in multi-occupation (such as blocks of flats), in large institutions (including schools, hostels, prisons and welfare centres), in premises where substantial numbers of people congregate and water is afforded for domestic use (such as canteens, hotels, lavatory blocks, restaurants, sports stadia, holiday camps and commercial premises generally) and in premises where s.60 of the Third Schedule of the 1945 Act has been applied (Paragraph 8.05).

Protection of water in industrial, trade and commercial installations

16.11. Water drawn within industrial, trade and commercial establishments for domestic use for example in offices, canteens and vending machines etc., should only be taken from drinking water quality supply pipes which are directly connected to the mains. Precautions which should be taken to protect the appliances and installations carrying water for drinking and other domestic use should be at least as stringent as those recommended in Chapters 7 and 8, where applicable (Paragraph 9.03 (i)).
16.12. Water supplied by a water undertaker for use other than for domestic and fire fighting purposes (see 16.15 below) within any industrial establishment, should only be taken to either (a) an approved break pressure cistern with Class 1 protection or (b) through a Type A air gap built into an appliance and so designed that water can be fed into it only at this point (Paragraph 9.03 (ii)).
16.13. No drinking water supply should be taken from a break pressure cistern or appliance described in 16.12 above or from any connected process water distributing pipe. Process water pipes should be made readily distinguishable from pipes which convey water of drinking quality by colour coding (Paragraph 9.03(iii)).
16.14. There should be no cross-connection between any pipe connected to the water undertakers' mains and any other pipe containing water from another source (Paragraph 9.03 (iv)).
16.15. All fire fighting water draw-off points, and fire mains (where such are specifically reserved for

the purpose) should be clearly marked and identifiable. Only fire fighting equipment should be connected to these points (Paragraph 9.03 (vi)).

16.16. The occupier of an industrial establishment should be required to be able at any reasonable time to demonstrate to the satisfaction of the enforcing authority that no cross-connections exist between the various supplies noted in 16.13 and 16.14 (Paragraph 9.03 (vi)).

16.17. The water undertaker should at his own cost take any additional precautions he deems to be necessary at the points of connection of the mains to high risk industrial installations (Paragraph 9.03 (vii)).

Protection of water used in hospitals

16.18. The recommendations apply to all hospitals and other medical and dental establishments be they National Health Service, publicly or privately owned. Such establishments are premises where a high degree of protection should be afforded not only to the water in the water undertaker's mains but also within the installations to protect patients and staff. In addition to protection against backsiphonage being afforded at every point of use whole installation protection should be provided (Paragraph 10.07).

16.19. Departments within hospitals and other medical and dental establishments which incorporate particularly hazardous situations, such as pathology laboratories should have installations which can readily be separated from the general water distribution system within the premises by means of Class 1 devices through which water passes to serve each hazardous area. Drinking water supplies should not be taken from installations so protected, and special measures should be taken to provide a separate and safe supply. Bidets with fixed sprays in their bases and bidets with hand held sprays should be permitted for use in hospitals and other medical establishments. Both the hot and cold water supplies to these appliances should be separated from the general water distribution system within the premises by means of Class 1 devices (Paragraph 10.08).

Protection of water used in ports, docks and harbours

16.20. All dockside hydrants and other fittings connected to drinking water systems should be clearly marked by signs and the words 'Drinking Water'. All dockside hydrants and other fittings connected to non-potable supplies should be clearly marked by signs and the words 'Not Drinking Water' (Paragraph 11.06 (i)).

16.21. The outlet end of every pipe used for supplying drinking water from shore mains to a ship should be so constructed that it will ensure a 'free fall' gravity flow delivery. An effective Type A air gap should be maintained at all times between any ship's installation and the shore drinking water mains (Paragraph 11.06 (ii)).

16.22. Water from shore required 'under pressure' on board ship should be supplied only in one of the following ways:

(a) If by direct connection, only from a separate non-potable main.
(b) From a storage cistern in the port area situated at sufficient elevation to provide the required flow by gravity.
(c) From a suitable mobile or fixed storage cistern at ground level used in conjunction with an automatic booster pump installation (Paragraph 11.06 (iii)).

16.23. Only properly protected and stored hoses should be permitted for use (Paragraph 11.06 (iv)).

16.24. At marinas and wharves where small boats obtain drinking water supplies, every standpipe and fitting to which a hose could be connected should incorporate an approved check valve and an anti-vacuum valve in combination (Paragraph 11.06 (vi)).

Protection of water used in agriculture and horticulture

16.25. Water derived from the public mains for domestic uses in farm houses, cottages and farm and horticultural buildings should only be taken from supply pipes which are directly connected to the public mains. Precautions to protect the appliances and installations carrying water for drinking and other domestic use should be those recommended in Chapter 7 (Paragraph 12.03 (a)).

16.26. Water supplied by a water undertaker for other use within any agricultural or horticultural premises, should only be drawn from pipes directly connected to the public mains in one of the following ways:

(a) into an approved break pressure cistern in accordance with App 5;
(b) into livestock watering troughs through shrouded Type A air gaps;
(c) through a Type A air gap built into the inlet of an appliance which should be so designed that water can be fed into it only at this point (Paragraph 12.03 (b)).

16.27. No pipes containing drinking water should be cross-connected to any of the cisterns in 16.26 or to pipes containing water from any other source (Paragraph 12.03 (d)).

16.28. The occupier of an agricultural or horticultural premises should be required at any reasonable time to be able to demonstrate that no cross connections exist between the various supplies on the premises (Paragraph 12.03 (e)).

Protection of mobile appliances

16.29. All mobile appliances should incorporate Type A air gaps at the inlets and the connections should be so designed that water can be fed in to the appliance only at those points. In addition, a check valve should be incorporated in each filling standpipe (Paragraph 3.07).

Enforcement

16.30. A Working Group should be formed following consultation with the National Water Council, to examine the need for registration or licensing of plumbers in the United Kingdom (Paragraph 14.02).

16.31. A basis for the minimum frequency of inspection of installations by the undertaker is

recommended (Paragraph 14.04).

16.32. Measures should be taken to strengthen powers to deal with contamination or likely contamination particularly by reinforcing any power to disconnect the supply to a consumer whose installation is likely to cause contamination of the mains.

Penalties for contraventions of the Water Act and byelaws in respect of offences which could lead to contamination should be reviewed (Paragraph 14.05).

16.33. Because the risks of backsiphonage arising out of properties at present connected to public mains are considerable, all existing installations should ultimately be brought into line with the recommendations in this report. In the case of existing installations, a period of five years should be allowed for the responsible water authorities to carry out programmes of observation and inspection of installations in their areas. At the end of that period, the position should be reviewed to determine the need for retrospection. During the five year period special attention should be given to premises where substantial numbers of people congregate, industrial premises, and buildings of multi-occupancy, such as blocks of flats (Paragraph 14.08).

The appropriate recommendations should be applied forthwith to existing installations where the particular circumstances of the installation are such that contamination of drinking water is likely to be caused and when an installation is extensively modified or extended (Paragraph 14.10).

16.34. As soon as possible, all new installations should incorporate the appropriate recommendations made in this report including 'whole installation protection' where applicable under paragraph 8.05 (Paragraph 14.09).

Continuing work

16.35. As new safety devices and measures are developed, series of tests similar to those we have carried out should be arranged and the results evaluated (Paragraph 15.01). Similarly, as new water using appliances and plumbing installations are developed, new situations of potential backsiphonage may arise and these should be evaluated and appropriate safety measures should be selected at an early date. Any new requirements for safety measures should be speedily incorporated under appropriate legislation (Paragraph 15.02).

16.36. To ensure that appliances and fittings comply with legislation, they should be type tested and approved by a single national test institute (Paragraph 15.03).

16.37. Agreement should be reached with recognised foreign certifying bodies for reciprocal approval and quality assurance arrangements for safety devices (Paragraph 15.04).

Glossary of terms

Approved approved by an authority recognised for the purpose by Government, or by a body with statutory responsibility.

Automatic flushing cistern a flushing cistern arranged to discharge its contents by siphonage at regular intervals, determined by the rate at which water is fed into the cistern.

Backsiphonage backflow of a liquid from an appliance or storage vessel into the pipe feeding it.

Ballvalve (float-operated valve) a valve, for controlling the flow of water into a cistern (or other vessel) which is operated by a lever arm with a float attached, the float riding on the surface of the water in the cistern (or vessel).

Branch supply pipe a lateral pipe which is connected to a supply pipe, conveying water under mains pressure to an appliance or water fitting.

Calorifier a storage vessel, not open to the atmosphere, in which a supply of water is heated. The vessel contains an element, such as a coil of pipe, through which is passed a supply of hot water or steam, in such a way that the two supplies do not mix, heat being transferred through the walls of the element.

Capacity 1. the volume contained in a vessel
2. of a storage cistern. The capacity of the cistern measured up to the water line.

Check valve an automatic valve for preventing reversal of flow, being opened by the flow and closed by gravity or a spring when the flow stops.

Circuit an assembly of pipes and fittings, forming part of a hot water system, through which water circulates.

Cistern a fixed container in which water is at atmospheric pressure. The water is usually supplied through a float operated valve.

Combination tap assembly a hot water tap and a cold water tap coupled together with a common delivery nozzle, which may be either fixed or swivelling, so as to discharge hot, cold or mixed hot and cold water.

Consumer a person supplied with water by a water undertaker.

Contaminated (water having become) water supplied by a water undertaker having become unfit for drinking and other domestic uses or likely to give rise to complaint from a consumer.

Cross connection a connection between two normally independent pipelines which permits flow from either pipeline into the other.

Device used in protection against backsiphonage, means any approved measure of appliance or combination of appliances specifically designed to prevent backflow or backsiphonage. Various types include:
- Air gaps—Types A and B
- Pipe interrupter
- Pipe loop
- Anti-vacuum valve
- Check valve
- Vent pipe
- Upstand

(see Chapter 5 for descriptions)

Direct system (hot water supply) a hot water supply installation in which the water supplied to the draw-off points is heated by a primary source of heat such as solid fuel, gas, electricity or oil.

Distributing pipe any pipe conveying water from a storage cistern, or from a hot water apparatus supplied from a feed cistern, and under pressure from that cistern.

Domestic use of water use of water by a consumer for drinking, washing, cooking and sanitary purposes.

Double outlet type combination tap assembly a combination tap assembly in which the streams of hot water and cold water are kept separate and do not mix until they emerge from the nozzle and which does not require the hot water and the cold water to be at the same pressure.

Dual flush cistern a WC flushing cistern which gives flushes of two different volumes, either of which can be selected by the user.

Expansion cistern a cistern forming part of a hot water heating installation, which accommodates the increase in volume of the water when hot; it can also act as the feed cistern for the installation.

Expansion pipe a safety pipe, or vent pipe, taken to a level above the associated feed cistern and often discharges into that cistern.

Feed cistern a cistern for supplying cold water to a hot water or heating water installation.

Feed pipe that part of a distributing pipe conveying water to a particular appliance or fitting.

Flushing cistern a cistern provided with a device for rapidly discharging the contained water and used with a sanitary appliance for the purpose of cleansing the appliance and carrying away its contents into a drain.

Fully pressurised installation	an installation where all the connected fittings and appliances are under pressure from a main.
Heating water	water heated by a primary source, flowing in a primary circuit to space heaters or to calorifiers in indirect hot water supply installations and not taken for use.
Hose union tap	a bib tap, the nozzle of which has a male thread for the attachment of a hose union
Hotwater cylinder	a cylindrical vessel for storing hot water to be drawn off for use.
Hot water supply	means heated water which may be drawn from an installation for use at baths, wash basins and so on
Indirect system (hot water supply)	a hot water supply installation in which the water supplied to the draw-off point is heated by means of a calorifier.
Invert	the lowest point of the internal surface of a pipe or channel at any cross-section.
Main	a pipe owned by the water undertakers for the general conveyance of water as distinct from the conveyance of water to individual premises.
Mixing valve	a valve in which separate supplies of hot water and cold water are mixed together, the outlet temperature in some mixing valves being regulated thermostatically and in others manually.
Overflow	1. flow from an overfilled vessel or sanitary appliance 2. that part of a vessel or sanitary appliance through which overflow is intended to take place.
Over-rim level	in relation to an appliance such as a sink, washbasin or bath means the level at which water commences to overflow over a substantial peripheral length.
Pressurised installation	that part of an installation directly connected to and under pressure from a main.
Primary circuit	a circuit in which water is used as a heat transfer medium and from which it is not drawn off for use.
Rising pipe	a pipe, in a building, through which water rises from the ground level to a storage cistern.
Safety pipe	a vent pipe from a domestic boiler.
Sanitary appliance	a fixed appliance in which water is used either for cleansing, culinary or drinking purposes before passing to waste, or for the flushing away of foul or waste matter.
Shower head	a water fitting, for use in a shower bath, from which water issues as a film or spray.
Silencing pipe	a short pipe attached to the outlet of a ballvalve to convey incoming water below the surface of the water already in the cistern.
Single outlet type combination tap assembly	a combination tap assembly in which the hot water and the cold water mix in the body of the tap before they emerge from the nozzle and which generally requires the hot and cold water to be at the same pressure.
Soffit	the highest point of the internal surface of a pipe at any cross section.
Standpipe	1. a rigidly supported vertical length of pipe emerging from the ground and terminating with a draw-off tap, serving as an outdoor water supply point. 2. a portable pipe fitting for fixing on a fire hydrant.
Stored installation	an installation in which connected fittings and appliances draw water from a cold water storage cistern by gravity only. (In most cases a kitchen and outside hose tap is connected directly to the supply pipe.)
Supply pipe	the pipe lying within the consumers' premises which conveys water under pressure from the mains to fittings.
Tap	a valve with a free outlet used as a draw-off or delivery point.
Unbalanced installations	an installation where most, if not all, the cold water draw off points are directly connected to the supply pipe and under mains pressure. Only the cold water feed to the hot water and heating apparatus is drawn from a storage cistern.
Vent pipe	a pipe, in a hot water apparatus, for the escape of air and for the safe discharge of any steam generated.
Warning pipe	an overflow pipe from a storage cistern which discharges in a conspicuous position.
Water fitting	anything fitted or fixed in connection with the supply and use of water.
Water line	a line marked inside a cistern to indicate the highest water level at which the ballvalve should be adjusted to shut off.
WC flushing cistern	a flushing cistern for flushing a WC pan.

Explanatory note on the appendices

1. The Appendices outline basic requirements for performance and installation of safety devices covered in Chapter 5.

2. These requirements have been designed so that the devices can give the appropriate degree of protection when installed in accordance with Appendices 4 and 9.

3. It is recognised that as experience in the design and use of these devices is gained, modifications may have to be made in the performance requirements. This is part of the long term continuing work described in Chapter 15. In particular the test criteria for the anti-vacuum valves and the check valve will require supplementing by more detailed specifications from time to time.

Appendix 1

(To be read in conjunction with Appendix 4)

Basic requirements of the air gap

Applicable to supply and feed pipes up to and including 40mm nominal bore

1. The most important characteristic of the Air Gap is that it has a free-flow section, which is fully open to the atmosphere thereby ensuring effective separation between the end of the feed pipe and the highest liquid level (critical level) downstream of the Air Gap. There are two types of Air Gap.

2. **Type A Air Gap**

An Air Gap associated with a vessel, such as a wash basin having an unrestricted overflow is known as a *Type A Air Gap*. An unrestricted overflow exists when an unobstructed inlet is so arranged as to discharge into a vessel at a vertical distance not less than the specified minimum distance 'S' given in Table 1 above the top edge of the receiving vessel. The Type A Air Gap shall satisfy simultaneously all the following requirements:

2.1. The inlet shall be unobstructed (free flow)

2.2. The direction of the free flow of water shall be downward and not more than 15° from the vertical

2.3. The effective visible distance measured vertically between the lowest part of the outlet of the supply or feed pipe and the top edge of the vessel shall be at least equal to the value 'S' given in Table 1.

2.4. There shall be no restriction to the overflow of the vessel.

Table 1

Nominal size of feed pipe		Minimum values of S
inch	mm	mm
$\leqslant \frac{1}{2}$	$\leqslant 14$	20
$> \frac{1}{2} \leqslant \frac{3}{4}$	$> 15 \leqslant 20$	25
$> \frac{3}{4} \leqslant 1\frac{1}{2}$	$> 20 \leqslant 40$	70

3. **Type B Air Gap**

An Air Gap which does not satisfy all the above conditions, particularly a case where the distance 'S' cannot be measured, may be a *Type B Air Gap*, provided it satisfies the following requirements:

3.1. In the case of an appliance containing a built-in Type B Air Gap, an authorised test institute shall verify that a free-flow section exists and that under test no liquid downstream of the Air Gap is drawn into the feed pipe when the device is subjected to the following test conditions:

3.1.1. All valves (in the direction of flow) upstream of the Air Gap should be fully open and all normal outlets (with the exception of any overflows) from the appliance should be closed.

3.1.2. The rate of flow of water through the feed pipe upstream of the device shall be the lesser of either 2m/s or that caused by a pressure of 6 bar measured upstream of the device.

3.1.3. The inflow of water shall be maintained until equilibrium is reached with the liquid level downstream of the Air Gap remaining constant (this level is the 'critical level').

3.1.4. With the water level maintained at the critical level and with all valves upstream of the Air Gap fully open, a negative pressure (vacuum) of 0.8 bar, measured relative to atmospheric pressure, shall be applied upstream of the Air Gap, or any valve or device which forms a constituent part of the Air Gap. The vacuum vessel shall be so designed that the negative pressure remains above 0.5 bar for at least five seconds. This negative pressure shall be measured in the pipe connecting the Air Gap to the vacuum plant and as near as possible to the Air Gap. The pipe connecting the Air Gap to the vacuum plant shall not restrict air flow through the Air Gap. To ensure this, negative pressure measured by the gauge P1 (see sketch Appendix 10, Fig 1), shall be compared with that measured by a similar gauge, P2, on the vacuum reservoir. The connecting pipe shall be considered to be suitable when the negative pressure (measured P1) falls similarly to that measured by P2, shown diagrammatically by the curve in Figure 2 in Appendix 10. The connecting pipe shall be considered to be unsuitable if the resulting curve is similar to that shown in Figure 3 in Appendix 10.

3.2. In cases where Type B Air Gaps are not built-in to appliances by manufacturers but are installed separately, and where it is not practicable to carry out type testing or on site tests in accordance with clauses 3.1.1 to 3.1.4 inclusive, the distance measured vertically between the lowest part of the outlet and the highest water level when the overflow is passing the maximum rate of flow shall not be less than 'S' given in Table 1.

Appendix 2

(To be read in conjunction with Appendix 4)

Basic requirements for the pipe interrupter

Applicable to connecting diameters up to 40mm in installations subject to mains pressure up to 10 bar

1. The purpose of the pipe interrupter is to prevent backsiphonage and backflow of water from that part of the installation which is downstream of the device, into the installation, and the public mains, upstream of the device. The pipe interrupter consists of a pipe through which water flows and into which air can enter through an annular aperture or through several holes or slits (hereafter referred to as 'air inlet apertures').

2. Type test conditions

To pass the type test, the following conditions must be fulfilled:

2.1. **General**

2.1.1. The pipe interrupter shall be a non-mechanical device without any moving or elastic (eg rubber diaphragm) parts.

2.1.2. The air inlet apertures shall be open and clear and the device shall be so designed and constructed that the air inlet apertures cannot be readily blocked or tampered with.

2.1.3. The pipe interrupter shall be suitable for use at temperatures up to 90°C.

2.2. **Dimensions**

2.2.1. The nominal diameter of the device shall be taken to be the average internal diameter of the feed pipe upstream of the device.

2.2.2. No dimension of an inlet aperture measured perpendicularly to the direction of air flow shall be less than 3mm.

2.2.3. The total cross sectional area of the air inlet apertures measured at right angles to the direction of the air flow shall not be less than the cross sectional area of the feed pipe.

2.2.4. The minimum diameter of the pipe interrupter downstream of the air inlet apertures shall not be less than the nominal diameter of the device.

2.3. **Materials**

The device shall be made of corrosion resistant material. If constructed of brass, the alloy shall not be prone to dezincification.

2.4. **Vacuum test**

2.4.1. Individual pipe interrupters

2.4.1.1. A vertical glass tube of the same diameter as the nominal diameter of the pipe interrupter and of length not less than 500 mm shall be connected at one end to the downstream end of the pipe interrupter. The other end of the glass tube shall be immersed in a vessel of water to a depth of not less than 20mm.

2.4.1.2. With all valves upstream of the pipe interrupter fully open, a negative pressure (vacuum) of 0.8 bar shall be applied upstream of the pipe interrupter. The vacuum vessel and pipework shall be so designed that the negative pressure remains above 0.5 bar for at least 5 seconds (see 4.1 and 4.2).

2.4.1.3. The rise in water level measured in the glass tube downstream of the device shall not exceed 50mm at any time.

2.4.2. Appliances with built-in pipe interrupters

2.4.2.1. Only pipe interrupters which conform with the foregoing criteria shall be built-in to manufactured appliances.

2.4.2.2. In addition the appliance shall be subject to testing in accordance with the following conditions:

2.4.2.3. The water level shall be set at the critical (spill over) level in the appliance. With its discharge pipe closed, a vacuum test shall be carried out in accordance with sub-clause 2.4.1.2. and clause 4.

2.4.2.4. No water downstream of the pipe interrupter shall be drawn up into the connecting feed pipe.

3. **Installation of individual pipe interrupters**

3.1. The minimum diameter of the downstream pipe connected to a pipe interrupter shall at no point be less than the nominal diameter of the device.

3.2. When the pipe interrupter is installed separately in pipework, it shall be installed with the lowest part of any air inlet aperture at least 200mm above the critical (overflow) level of water in any appliance, or installation, which is connected downstream of the device.

4. **Vacuum Test Installation**

4.1. The negative pressure of 0.8 and 0.5 bar shall be measured with reference to atmospheric pressure.

4.2. The negative pressure shall be measured in the pipe connecting the device under test (the test specimen) to the vacuum plant, and as near as possible to the specimen. The pipe connecting the specimen to the vacuum plant shall not restrict the air flow through the specimen.

4.3. To ensure this, the negative pressure measured by the gauge P1, (see sketch Appendix 10, Figure 1) shall be compared with that measured by a similar gauge, P2, on the vacuum reservoir. The connecting pipe shall be considered to be suitable when the negative pressure measured by P1 falls in a similar way to that measured by P2, (as shown by the curve in Figure 2 in Appendix 10). The connecting pipe shall be considered to be unsuitable if the resulting curve is similar to that shown in Figure 3 in Appendix 10.

Appendix 3

(To be read in conjunction with Appendix 4)

Basic requirements for the pipe loop

The essential characteristic of the pipe loop is that water in the installation downstream of the device cannot backflow or backsiphon to the installation, or mains, upstream of the device.

Installation conditions

1. The safety distance between the highest point of the pipe loop and the bottom of the pipe loop on each side shall be at least 10.50m.
2. At no point in the pipe loop shall a branch connection or drain valve be incorporated.
3. The highest equivalent head of water at any point in the installation downstream of the pipe loop shall be at least 10.50m below the highest point of the pipe loop.
4. No pump or pressurised vessel shall be installed downstream of the pipe loop which could raise the equivalent head of water given in 3 above by more than the equivalent of 0.05 bar.

Appendix 4

Use and installation of devices without moving parts

1. The only recommended safety devices without moving parts are:
- air gap (Types A and B), in accordance with Appendix 1
- pipe interrupter, in accordance with Appendix 2
- pipe loop, in accordance with Appendix 3

2. The normal and most reliable protection against contamination of drinking water where there is a Class 1 risk situation (see Backsiphonage Report paragraphs 4.04 and 4.05) is provided by the Type A Air Gap. In certain circumstances, only the Type A Air Gap should be used.

3. An approved break pressure cistern may be used in conjunction with safety devices to afford Class 1 protection, providing flow from the cistern is by gravity at all times and no pump or pressurised vessel is permitted downstream. In this way protection may be afforded against possible contamination from industrial process water, w.c. pans and the like. Installation conditions for this application are given in Appendix 5.

4. Where there is a situation involving more than one risk (for example, in a dishwashing machine which is equipped with a water softener) either (a) the appropriate safety device shall be incorporated upstream of each risk situation or (b) the most effective safety device shall be installed upstream of the risk situation which is nearest to the public main.

5. Adequate precautions shall be taken against tampering with a safety device. This shall be deemed to be achieved:

(a) when built into a manufactured appliance, such as a washing machine, the safety device is securely attached to the appliance by the manufacturer. It should be so designed that it cannot be removed by means of household tools. If the safety device is fitted outside the housing of the appliance, the fastenings shall be sealed. Where there is any possibility of hoses being fitted, air inlets blocked, or unauthorised connections being made, which might make the safety device less effective, it shall be suitably shielded by a cover from such action.

(b) when built or incorporated in an installation, pipe interrupters shall be fitted in accordance with manufacturers' instructions. All devices shall be located and installed so as to deter possible interference. Where a tap or open-ended pipe forms the upstream part of an air gap it shall be designed so as to make it difficult to fit a hose connection. No connections shall be made to either leg of a pipe loop.

6. The Air Gap Type B, Pipe Interrupter, and Pipe Loop are only permissible for use as safety devices if the following requirements are met downstream of the particular safety device:

(a) there shall be no cross-connections to other supplies of water under pressure;

(b) the safety distances downstream of the devices specified in the individual appendices shall be met;

(c) the pressure in the system downstream of the device shall not be capable of being increased so as to produce an effective free water level above those referred to in (b) above;

(d) adequate overflows shall be provided to ensure that any free water level downstream of the device does not rise above the levels referred to in (b).

7. In the case of manufactured safety devices or of safety devices incorporated in appliances, a type sample of the device or of the safety device incorporated in the appliance shall be type tested and assessed by an approved test institute.

Appendix 5

(To be read in conjunction with Appendix 4)

The break pressure cistern

1. **Introduction**

1.1. Protection against contamination of the drinking water supply may be effected by interposing a break pressure cistern between a potentially contaminated liquid and the water supply system.

2. **Definition**

2.1. A break pressure cistern is a vessel (a) which is filled by a pipe conveying water at or above atmospheric pressure and (b) in which water is stored at atmospheric pressure for subsequent use.

2.2. In normal circumstances, a break pressure cistern is equipped with (a) a piped overflow (b) a float operated or other type of automatic control valve on the inlet pipe and (c) a cover.

3. **Types**

3.1. There are two basic types of break pressure cistern installations, as follows:

Type (a) Where water flows from the cistern under gravity pressure to all points of use at all times, and no pump or pressure vessel is permitted for use downstream of the cistern.

Type (b) Where water does not necessarily flow from the cistern under gravity or where the pipework downstream of the cistern may be pressurised by the use of pumps, pressure vessels, heating or other means which may raise the manometric head above that of the outlet level of the cistern.

4. **Installation conditions for break pressure cisterns connected to drinking water pipes**

4.1. The protection necessary at the break pressure cistern to prevent contamination of the mains depends upon the type of installation (see 3) and the purpose for which water is used downstream of the cistern. This protection shall be as follows:

4.1.1. Type (a) Para 3.1.

(a) The break pressure cistern shall be situated and constructed in such a way that the top edge of any vessel containing potentially contaminated liquid downstream is not less than 300 mm vertically below the invert level of the piped overflow of the cistern and the lowest inside base of the break pressure cistern shall be not less than 15mm above the top edge of all vessels containing potentially contaminated liquid.

(b) A safety device shall be installed at the inlet to the break pressure cistern to prevent backsiphonage from the cistern to the mains. Any one of the following safety devices without moving parts may be used:

Type A air gap (Appendix 1)
Type B air gap (Appendix 1)
Pipe Interrupter (Appendix 2)

4.1.2. Type (b) Para 3.1.

(a) Where the break pressure cistern is used in association with domestic heating water installations, a Type B air gap may be permitted as the approved safety device to prevent backsiphonage from the cistern. No overflow from a cistern serving the primary circuit of a heating water installation shall be permitted to discharge into any other break pressure cistern.

(b) In all other cases, the only permissible safety device shall be the Type A air gap.

4.2. The break pressure cistern shall be properly covered in the following circumstances:

(a) Where the cistern is situated in the same room or the same confined area as a potentially contaminated liquid.

(b) Where there is any chance of disturbance or splashing of potentially contaminated liquid causing contamination of the contents of the cistern.

4.3. Whenever an overflow pipe from a break pressure cistern discharges to a vessel containing potentially contaminated liquid, it shall discharge into the air not less than 150mm above the top edge of that vessel.

4.4. Whenever a break pressure cistern supplies water to several vessels containing potentially contaminated liquid, the provisions of this document shall apply to each and every vessel. The safety device to be installed on the break pressure cistern inlet shall be the highest category as appropriate from paragraphs 4.1.1. and 4.1.2.

(For example, a break pressure cistern supplying one vessel by gravity and another by means of boosting downstream of the cistern would be provided with a Type A air gap on the cistern inlet).

Appendix 6

Basic requirements of the check valve

1. **Range of application**
These basic requirements apply to check valves suitable for operation at pressures up to 10 bar, working temperatures up to 90°C and nominal union diameters up to 50mm.

2. **Nominal size**
The nominal size is defined as the size of the connection on the upstream (inlet) side of the fitting.

3. **Function**
The function of the check valve is to prevent potentially contaminated liquid from flowing back into a drinking water system.
The check valve is an in-line fitting having one or more movable parts. It allows water to flow in one direction only. When there is no flow, the valve is closed. It thereby automatically prevents backflow.

4. **Type testing**
The following conditions shall be fulfilled for type testing check valves.
4.1. *General*
4.1.1. Those parts which are subjected to water pressure shall be designed to work at operating pressures up to 10 bar.
4.1.2. Only materials which would not be adversely affected by any water likely to be handled in use and resistant to corrosion and ageing shall be used. Those materials which come into contact with drinking water shall not cause or be likely to cause contamination of the water. When brass is used it shall be of a composition which is resistant to dezincification.
4.1.3. Seals shall be permanently elastic, firmly secured and heat resistant. Adherent seals or surface coatings containing grease shall not be used.

4.2. *Test Conditions*
4.2.1. The testing station shall decide which is the most unfavourable position for mounting (for example, the direction of flow horizontal or downwards). Tests shall be conducted in this most unfavourable mounting position.
4.2.2. Testing the strength of the body under bending and tightness of shut off. The test piece will be mounted in a test arrangement as shown in 6.1.
(a) The shut off valves Nos 2, 7 and 9 are opened, (see 6.1) and 3, 4 and 10 are shut. Water flows through valves 2, 6, 7, the end of the plastic hose 8 and valve 9.
(b) Valve 9 is closed and the level of the end of the clear plastic hose 8 shall be adjusted so that HK = 30mm.
(c) After the air is completely removed from the system, valve No 3 is opened and valve No 2 is closed slowly. The water meniscus at the end of the plastic hose is observed for 3 minutes. If this meniscus disappears the check valve is leaking.
(d) Valve 7 is closed and valve 10 opened and a pressure of 16 bar is slowly applied by the test pump. No leaks or permanent distortions shall appear during the test.
(e) An appropriate bending moment is applied to the check valve in accordance with the following table and 6.2.

Bore of inlet pipe mm	15	20	25	32	40	50
*Bending Moment NM	200	300	400	500	600	700

*NOTE These values are provisional and are for metal valves only. Interpolation should be resorted to for intermediate sizes.
(f) Repeat operations (a) to (d).
(g) Remove bending moment applied in operation (e).
(h) Release 16 bar pressure applied in operation (d) by closing valve No 10 and opening valve No 7.
(i) Repeat operations (a) to (c) ; the valve shall not leak.
4.2.3. *Testing the pressure necessary to open the valve*
At the conclusion of test 4.2.2., the glass tube No 5 is filled with water (about 1m high), valve No 3 is closed and valve No 4 is opened. Part of the water in glass tube No 5 flows through the test specimen until a condition of equilibrium is established. After three minutes, measurement H° is ascertained. The value of it shall be at least 100mm.

4.2.4. *Testing the tightness of the check valve*
The check valve shall be subjected to an internal pressure of 25 bar at a water temperature of 90° ± 5°C. Pressure is maintained for two minutes. No leakage shall occur in this period.

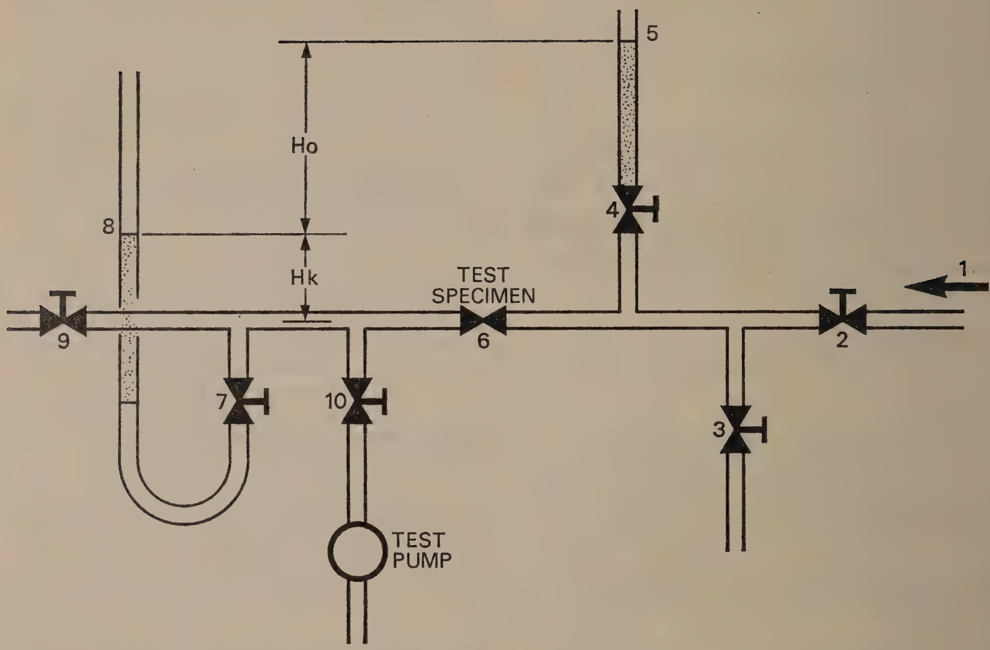
4.2.5. *Fatigue testing*
The check valve shall be pressurised alternately from the inlet and outlet sides under a pressure of 16 bar on the outlet and zero pressure on the inlet. The number of cycles shall be;
50 000 with cold water and
50 000 with hot water at 90°C (±5°C).

Each cycle shall consist of:
7 seconds normal flow*
½ second change-over to an outlet-side pressure of 16 bar and nlet-side pressure of 0 bar,
maintenance of the outlet-side pressure of 16 bar and the inlet-side pressure of 0 bar for 7 seconds,
½ second relieving the pressure on the outlet side and changing over to the normal flow.
*Normal flow shall be a flow rate corresponding to a velocity of 2 m/s in the inlet pipe.

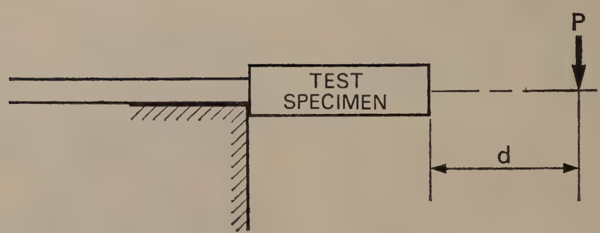
4.2.6. *Test at high water velocity*
Water is passed through the check valve for 10 minutes at a velocity of 5 m/s at the inlet connections.
The seals shall not be damaged or dislodged.

4.2.7. *Final test*
On the conclusion of the foregoing tests that portion of the tightness test set out in paragraph 4.2.2. operation (a) to (c) is repeated.
No leakage shall be discernible through the valve.

6.1



6.2



Check Valves:
Testing the strength of the body under bending & tightness of shut-off

Appendix 7

Basic requirements for terminal anti-vacuum valve

1. **Range of application**
These basic requirements apply to terminal anti-vacuum valves with a permissible operating pressure up to 10 bars and temperature up to 90°C and a nominal size up to 50mm.

2. **Nominal size**
The nominal size is defined as the size of the connection on the water inlet side of the valve.

3. **Function**
The terminal anti-vacuum valve has the function of limiting vacuum pressures in an installation thereby preventing backsiphonage into the drinking water system.
The terminal anti-vacuum valve is a fitting through which water does not flow, and with air entry apertures which are closed when the installation is under positive pressure. The air entry apertures open to atmosphere on application of a negative pressure in the connected pipework and limit the magnitude of the negative pressure. Where a terminal anti-vacuum is to be capable of releasing air from an installation this should be specified. However this capability shall not detract from its main function as an anti-vacuum valve.

4. **Type test**
4.1 *General*
4.1.1. Those parts which are subjected to water pressure shall be designed to work at operating pressures up to 10 bars.
4.1.2. Only materials which would not be adversely affected by any water likely to be handled in use and resistant to corrosion and ageing shall be used. Those materials which come into contact with drinking water shall not cause or be likely to cause contamination of the water. When brass is used it shall be of a composition which is resistant to dezincification.
4.1.3. The diameter of the air inlet apertures measured at right angles to the direction of airflow at no point shall be less than 3mm.
4.1.4. The air inlet apertures shall be protected so that they cannot become blocked through carelessness or by being tampered with.
4.1.5. Seals shall be permanently elastic, tightly held, and heat resistant; adherent seals or surface coatings containing grease are not permissible.
4.1.6. The connection of drainage pipes to terminal anti-vacuum valves shall be effected through air gaps (in accordance with Appendix A) or pipe interrupters (in accordance with Appendix B).

4.2. *Test conditions*
4.2.1. Durability test
The anti-vacuum valve shall be stressed with a pressure alternating between 0 and 25 bar (as in Fig 7.2). The test shall be carried out over 1,000 cycles, of which the first 500 cycles shall be with hot water at 90°C (±5°C) followed by 500 cycles with cold water at 15°C (±5°C). The test arrangement is shown in Fig 7.1.

4.2.2. Tightness test
Test equipment according to Fig 7.2 shall be used for testing the tightness at the limit of the pressure/negative-pressure region. The flow of water shall be adjusted so that the anti-vacuum valve allows air to enter when the transparent hose is lowered. No water shall issue from the air-inlet apertures, whatever the rate at which the hose is raised and lowered. This test shall be performed before and repeated after the durability test, using the same test equipment, and in each instance shall be repeated ten times. The test conditions shall be fulfilled each time.

4.2.3. Test of response height
The test sample shall be connected to one arm of a T piece as shown in Fig 7.4. The second arm of the T piece shall be connected to a negative pressure pipe and the third to a glass tube whose bore is about the same as the bore of the valve connection and of length which is not shorter than 500mm. The other end of the transparent hose shall be dipped to a depth of at least 20mm in a water bath.
The negative pressure at which the cut-off element begins to open shall be determined by slow opening of the valve fitted in the negative pressure pipe. The peak value should not exceed 120mm.

4.2.4. Test of the suction height
A vertical transparent hose with an inside diameter approximately the same as the inside diameter of the union of the fitting and not less than 2.0m in length shall be connected to the third leg of the T piece of the same size. The other end of the hose shall be immersed to a depth of at least 20mm in a water bath.
In the feed pipe a negative pressure of 0.8 bar shall be applied. This negative pressure shall not drop below 0.5 bar over a period of at least 5 seconds. The suction height (settled value) shall not exceed 1800mm.

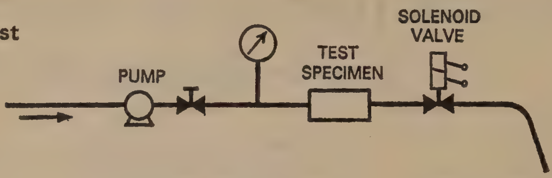
4.2.6. Endurance test
Two test specimens (no 1 and no 2) shall be set up in accordance with figure 7.3 and purged through. The flow of water shall then be cut off with the hose raised.

A third test piece (no 3) shall be set up according to fig 7.5 and purged through. The valve installed downstream of the test specimen shall be closed. The test specimen (no 1) shall be subjected to 500mm head of water for 30 days. Test specimen, no 2, shall be subjected to tightness test 4.2.2 for six times daily for 30 days. Test specimen, no 3, shall be

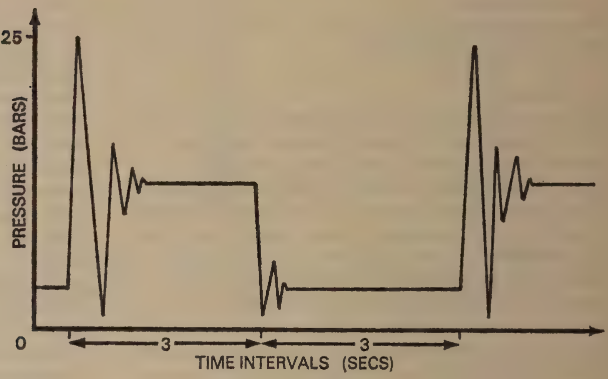
stressed for 30 days under a static water pressure of between 5 and 6 bars. After 30 days, test specimens nos 1, 2 and 3 shall be subjected to tests for response height. The values thereby obtained shall not deviate by more than 20mm from the original values and shall not be greater than 120mm.

4.3. *Mass-produced appliances with built-in terminal anti-vacuum valves*
In addition to type tests carried out on the individual terminal anti-vacuum valves, the mass produced appliances into which they are built shall also be type tested.

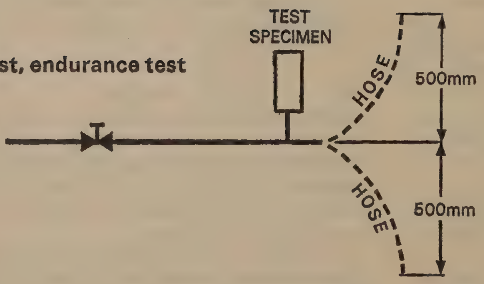
7.1
Durability test



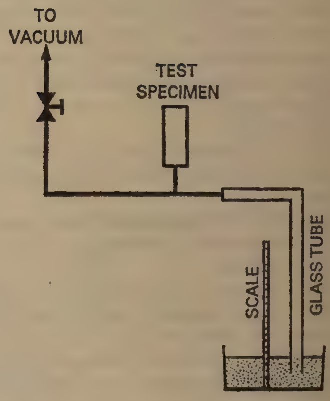
7.2
Durability test (pressure variation)



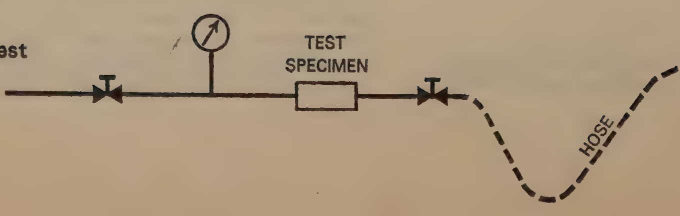
7.3
Tightness test, endurance test



7.4
Response height test, suction height test



7.5
Endurance test



Appendix 8

The basic requirements of the in-line anti-vacuum valve

1. **Range of application**
These basic requirements apply to in-line anti-vacuum valves with a permissible operating pressure up to 10 bars and temperatures up to 90°C and a nominal size up to 50mm.

2. **Nominal size**
The nominal size is defined as the size of the connection on the water inlet side of the valve.

3. **Function**
The function of the in-line anti-vacuum valve is to limit vacuum pressures in an installation thereby preventing backsiphonage of liquid downstream of it into the drinking-water system.
The in-line vacuum valve is a fitting through which, in normal operation, water flows. The valve has air-inlet apertures which are closed as long as the pipe is under positive pressure. When a negative pressure occurs, the air-inlet apertures open automatically and limit the magnitude of the negative pressure in the installation connected downstream of the valve.

4. **Type test**
4.1. *General*
4.1.1. Those parts which are subjected to water pressure shall be designed to work at operating pressures up to 10 bars.
4.1.2. Only materials which would not be adversely affected by any water likely to be handled in use and resistant to corrosion and ageing shall be used. Those materials which come into contact with drinking water shall not cause or be likely to cause contamination of the water. When brass is used it shall be of a composition which is resistant to dezincification.
4.1.3. The diameter of the air inlet apertures measured at right angles to the direction of airflow at no point shall be less than 3mm.
4.1.4. The air inlet apertures shall be protected so that they cannot become blocked through carelessness or by being tampered with.
4.1.5. Seals shall be permanently elastic, tightly held, and heat resistant; adherent seals or surface coatings containing grease are not permissible.

4.2. *Test conditions*
4.2.1. Testing the bending strength of the body
The body of the test piece shall be subjected to a bending moment in accordance with the following table, and Fig 8.1.

Bore of inlet pipe mm	15	20	25	32	40	50
Bending Moment* Nm	200	300	400	500	600	700

*NOTE These values are provisional and are for metal valves only. Interpolation should be resorted to for intermediate sizes.

With the appropriate bending moment applied, the pressure on the inlet side shall be increased to 16 bars, and then reduced again to 0 bar.
No leaks or permanent distortions shall appear at any time during the test.
The tightness test then follows in accordance with section 4.2.3.

4.2.2. Durability test
The anti-vacuum valve shall be stressed with a pressure alternating between 0 and 25 bar, (as in Fig 8.2). The test shall be carried out over 1,000 cycles, of which the first 500 cycles shall be with hot water at 90°C (±5°C) followed by 500 cycles with cold water at 15°C (±5°C).
The test arrangement is shown in Fig 8.3.

4.2.3. Tightness test
Test equipment according to figure 8.4 shall be used for testing the tightness at the limit of the pressure/negative-pressure region. The flow of water shall be adjusted so that the anti-vacuum valve allows air to enter when the transparent hose is lowered. No water shall issue from the air-inlet apertures whatever the rate at which the hose is raised and lowered.
This test shall be performed before and be repeated after the durability test, using the same test equipment, and in each instance shall be repeated ten times. The test conditions shall be fulfilled each time.

4.2.4. Test of response height (Fig 8.5)
A vertical glass tube with an inside diameter approximately the same as the inside diameter of the union on the fitting, and not less than 500mm in length, shall be connected to the outlet side of the test piece. The other end of the glass tube shall be immersed to a depth of at least 20mm in a water bath. The inlet side of the test specimen shall be connected to a vacuum pipe. The peak value reached shall not exceed 120mm when the fitting built into the vacuum pipe is slowly opened.

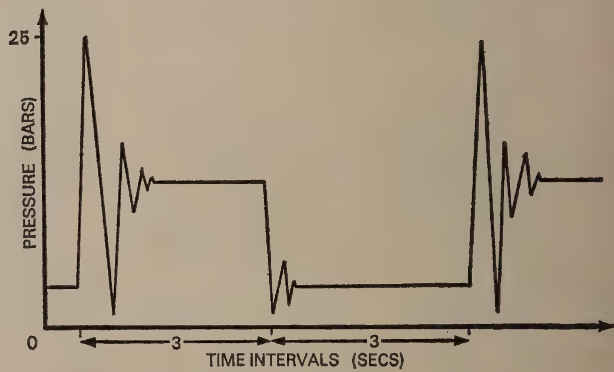
4.2.5. Testing the suction height (Fig 8.5)
A vertical transparent hose with an inside diameter approximately the same as the inside diameter of the union of the fitting, and not less than 500mm in length, shall be connected to the outlet side of the test specimen. The other end of the hose shall be immersed to a depth of at least 20mm in a water bath. The test specimen shall be connected to the vacuum tank by a pipe.
The test shall be performed with a negative pressure of 0.8 bar and a fall in pressure to 0.5 bar is permissible during the test.
The suction height (peak value) shall not amount to more than 150mm.

4.2.6. Endurance test

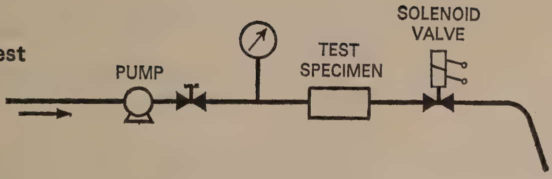
Two test specimens (no 1 and no 2) shall be set up in accordance with figure 8.4 and purged through. The flow of water shall then be cut off with the hose raised.
A third test piece (no 3) shall be set up according to figure 8.6 and purged through. The valve installed downstream of the test piece shall be closed. The test specimen (no 1) shall be subjected to 500mm head of water for 30 days. Test specimen, no 2, shall be subjected to tightness test 4.2.3 six times daily for 30 days. Test specimen, no 3, shall be stressed for 30 days under a static water pressure of between 5 and 6 bars. After 30 days, test specimens nos 1, 2 and 3 shall be subjected to tests for response height. The values thereby obtained shall not deviate by more than 20mm from the original values and shall not be greater than 120mm.

8.1
Bending strength of body

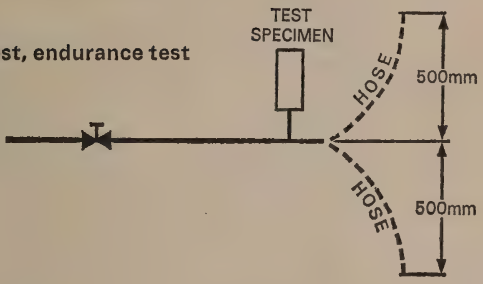
8.2
Durability test (pressure variation)



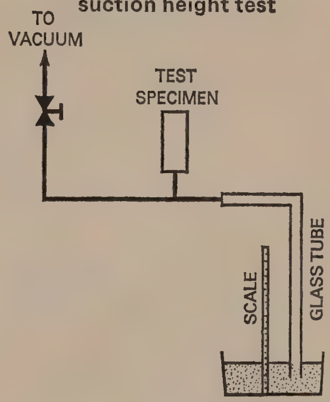
8.3
Durability test



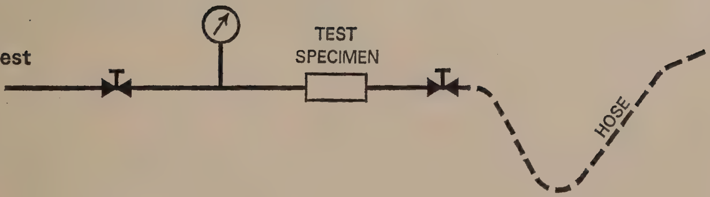
8.4
Tightness test, endurance test



8.5
Response sensitivity test suction height test



8.6
Endurance test



Appendix 9

Use and installation of safety devices with moving parts

1. Safety devices with moving parts for use in the protection against contamination of water in the installation or in the public mains are:
– In-line anti-vacuum valve, in accordance with Appendix 8.
– Terminal anti-vacuum valve, in accordance with Appendix 7.
– Check valve, in accordance with Appendix 6.

2. Where two devices are combined, for instance in a combination in-line anti-vacuum and check valve assembly, each part shall comply with the respective Appendix referred to in 1 above.

3. Adequate precautions should be taken to prevent a safety device being tampered with as follows:

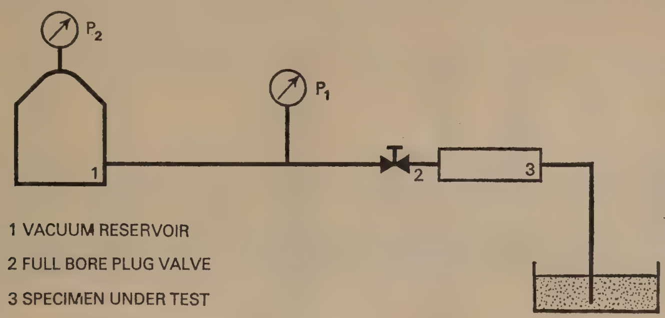
(a) When built into a manufactured appliance, such as a domestic water softener, the safety device or combination of safety devices, should be securely attached to the appliance by the manufacturer. Devices should be so designed that they cannot be removed by means of household tools. If devices are fitted outside the housing of the appliances, the fastenings should be sealed. Where there is any possibility of hoses being fitted, air inlets blocked, or unauthorised connections being made, which might make a safety device less effective, it should be suitably shielded by a cover from such action.

(b) When built or incorporated in an installation, anti-vacuum valves and check valves should be fitted in accordance with manufacturer's instructions. All safety devices should be located and installed so as to deter possible interference and to facilitate routine inspection, maintenance and replacement.

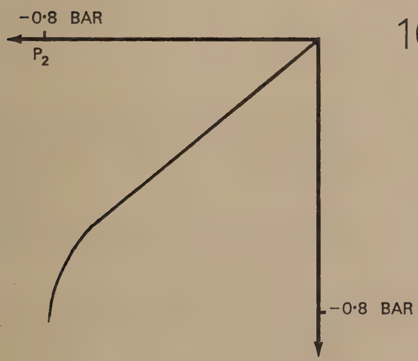
4. In the case of manufactured safety devices or of devices incorporated in appliances, a type sample of the device or of the safety device incorporated in the appliance shall be type tested.

Appendix 10

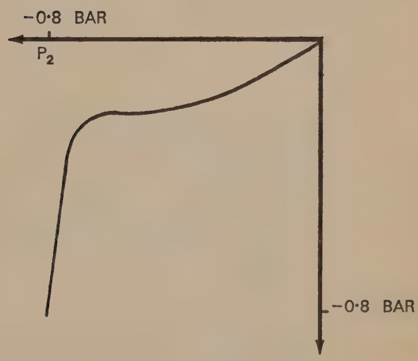
10.1



10.2

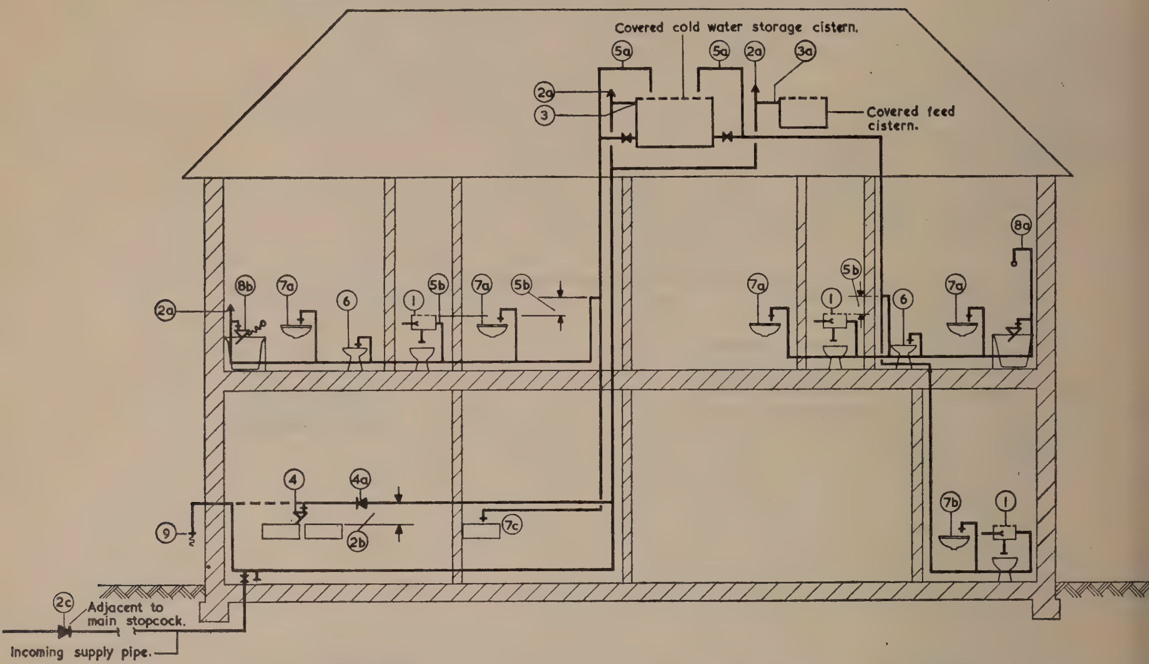


10.3



Large Residence

Stored installation for hot and cold water supply except for supply to the kitchen tap, showing optional whole installation protection



Notes relative to hot and cold supplies

(Whole installation protected)

i Pressurised part of system (optional)

2a Anti-vacuum valve (terminal type)

2b Upstand and take off to kitchen tap (appropriate distance above associated highest water levels at connected appliances)

2c Check valve on the supply pipe

ii Additional protection of pressurised part of installation

4 Cold kitchen tap or single outlet combination type tap assembly (when pressures are suitable or double outlet type) Class A air gap

4a Check valve on cold feed to single outlet type combination tap assembly

3 Class 2 protection of cold water storage cistern inlet

3a Class 2 protection at feed cistern serving boiler primary circuits

9 Garden/garage hose union connection (Class 2 risk); combined check and anti-vacuum valve

i Stored part of system (optional)

5a Vent pipe

5b Upstands

ii Additional protection of stored part of installation

1 WC pan (Class 1 risk) Flushing cistern (Class 2 protection on inlet)

6 Bidet (Class 1 risk) over-rim type

7a Upstairs wash basin: in absence of 5a and 5b; Type A air gaps

7b Downstairs wash basin: no restriction but Type A air gap should be no problem

7c Downstairs sinks: no restriction but Type A air gap should be no problem

8 Bath without shower fitting (not illustrated) in absence of 5a and 5b; Type A air gap

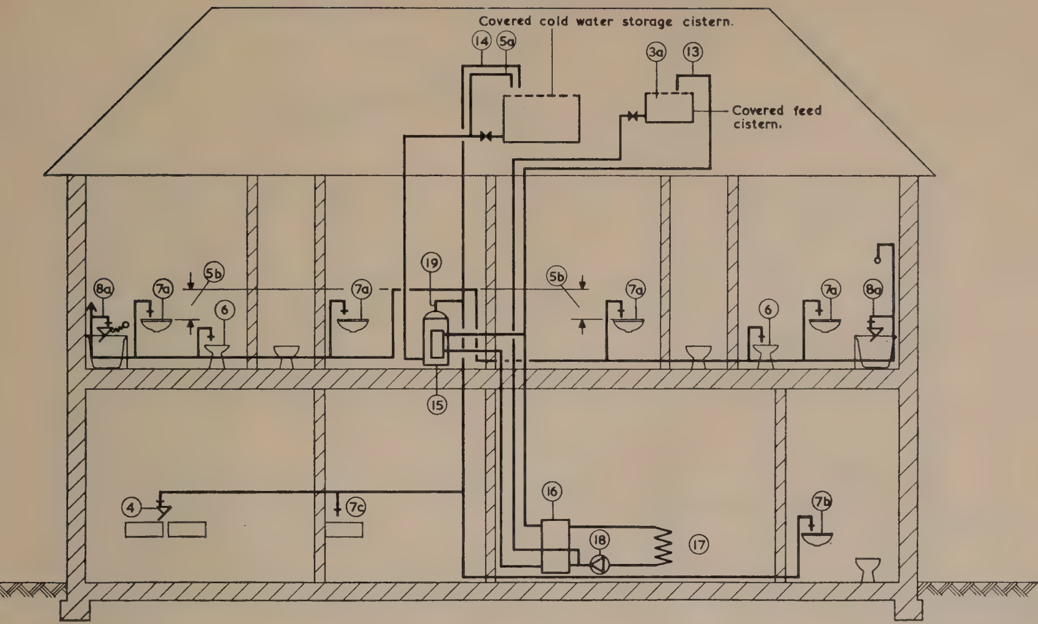
8a Bath with fixed shower: no special measures necessary at shower

8b Bath with flexible shower unit (Class 2 risk) in absence of 5a and 5b; combined check and anti-vacuum valve necessary

Not illustrated

10	Clothes washing machine	Built in Class 2 protection
11	Dishwashing machine	Built in Class 2 protection
12	Water softener	Built in Class 3 protection

Hot water supply



Notes relative to hot water supply only

13 Vent pipe to feed cistern
14 Vent pipe to cold water storage cistern
15 Calorifier
16 Boiler with fitted safety valve
17 Radiator circuit
18 Circulating pump
19 Upstands

Legend, applicable to Drawings A, B, C, D

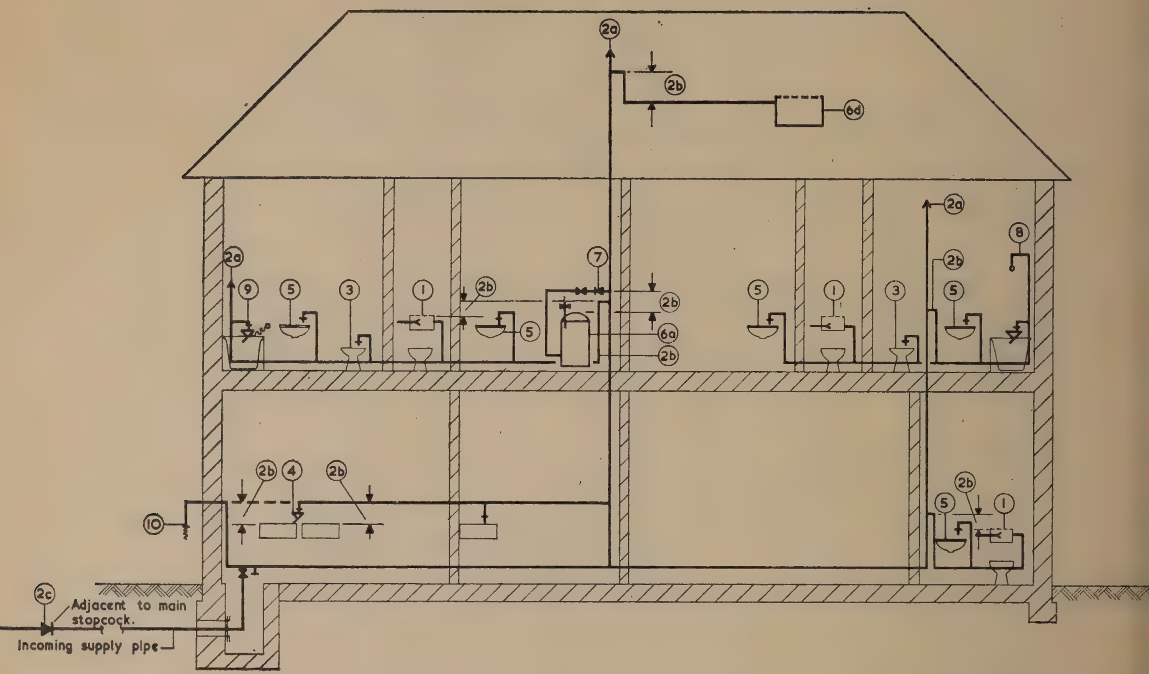
Terminal anti-vacuum valve
Stop valve
Check valve
Draw-off tap
Shower
Type B air gap in a break pressure cistern
Circulating pump
Hand spray
Mixing unit for hot and cold water
Safety valve
Thermostatic relief valve
Drain valve
Garden/garage hose union connection

Large Residence

Fully pressurised hot and cold water supply, heating water primary circuit non-pressurised, showing optional whole installation protection

Drawing B

Cold water supply



Notes relative to hot and cold water supply

(Whole installation protected)

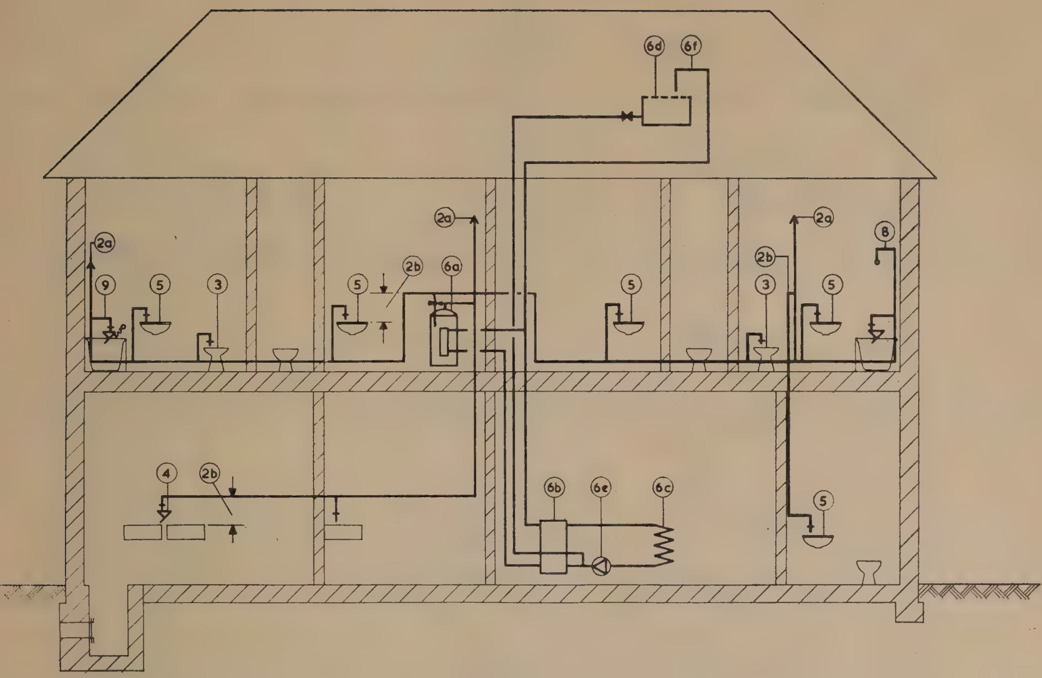
1 WC pan (Class 1 risk) Flushing cistern (Class 2 protection on inlet)
2a Terminal anti-vacuum valve (part of whole installation protection)
2b Upstands (take off appropriate distance above associated highest water levels at connected appliances)
3 Bidet (Class 1 risk) over-rim type
4 Single outlet type – combination tap assembly
5 Wash basin : outlet taps set at Type A air gap (preferably)
6a Calorifier
6b Boiler with fitted safety valve
6c Radiator circuit
6d Covered feed cistern with Class 2 protection on inlet (primary circuit heating water supply)
6e Circulating pump
6f Boiler (primary circuit) expansion pipe
7 Location only for check valve (possibly may be required at a later date)
8 Fixed shower fitting
9 Flexible hose shower attachment (Class 2 risk) protected by 2a and 2b
10 Garden/garage hose tap connection (Class 2 risk)
2c Check valve (part of whole installation protection)

Notes

i Although items 2a and 2b are parts of the optional 'whole installation' protection, item 2a at least would be required to automatically vent air from the installations
ii Satisfactory service can be assured only where water pressures constantly available at levels above the highest connected fitting.

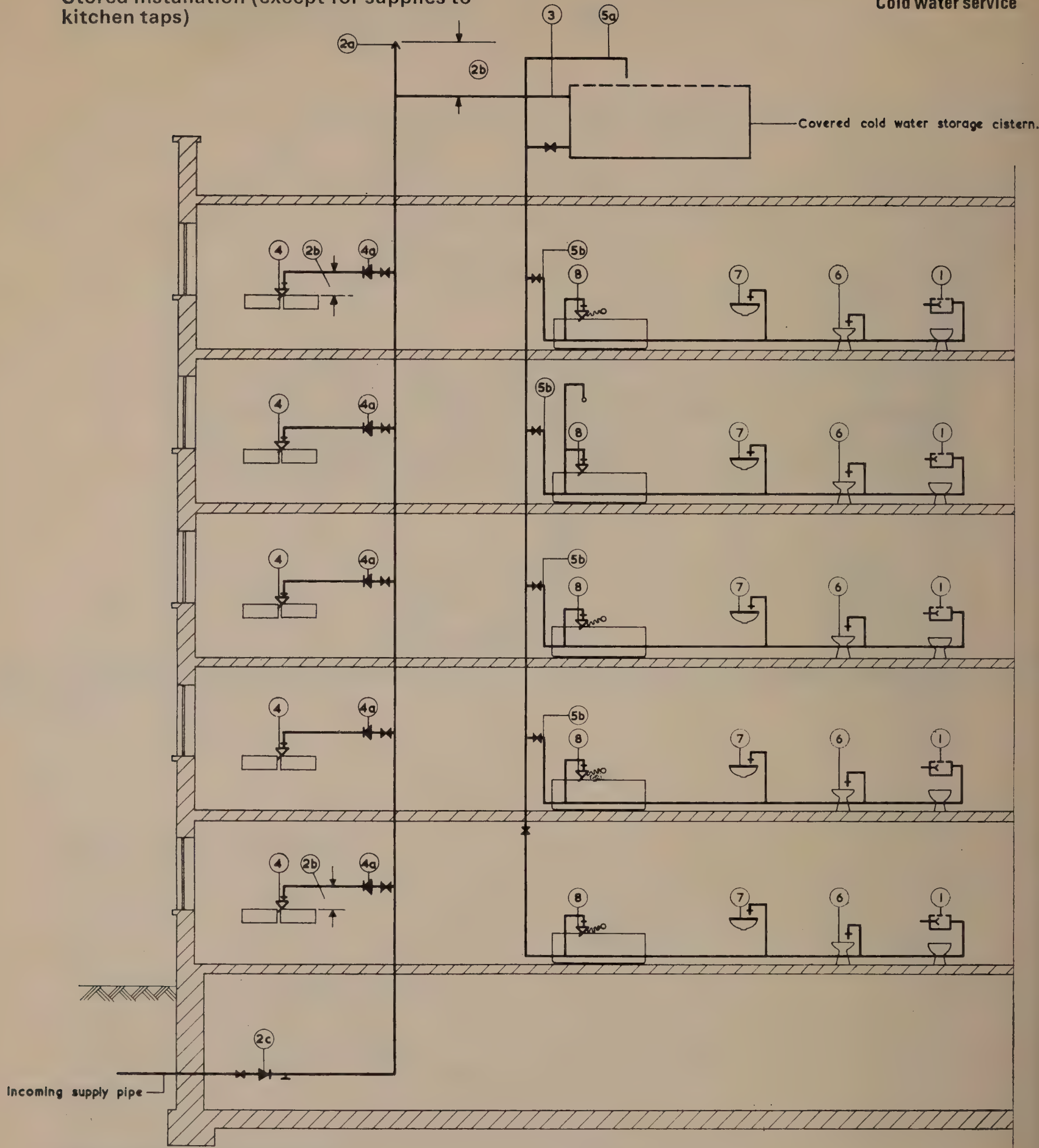
Drawing B

Hot water supply and heating water primary circuit



Multi-storey block of flats

Stored installation (except for supplies to kitchen taps)



Notes relative to hot and cold supply

(Whole installation protected)

i Pressurised part of system

2a Anti-vacuum valve

2b Upstands at offtakes to kitchen taps and boiler feed cistern

2c Check valve

ii Additional protection of pressurised part of system

4 Cold kitchen tap or single outlet combination type tap assembly (when pressures are suitable) or double outlet type. Type A air gap.

4a Check valve on cold feed if single outlet type combination tap assembly is used in kitchen (not required when single 2c is provided)

3 Class 2 protection at cold water storage cistern inlet

Not illustrated

3a Class 2 protection of feed cistern with centralised boiler system

9 Garden/garage hose union connection Class 2 combined anti-vacuum and check valve

10 Dishwashing machine — Built in Class 2 protection

11 Clothes washing machine — Built in Class 2 protection

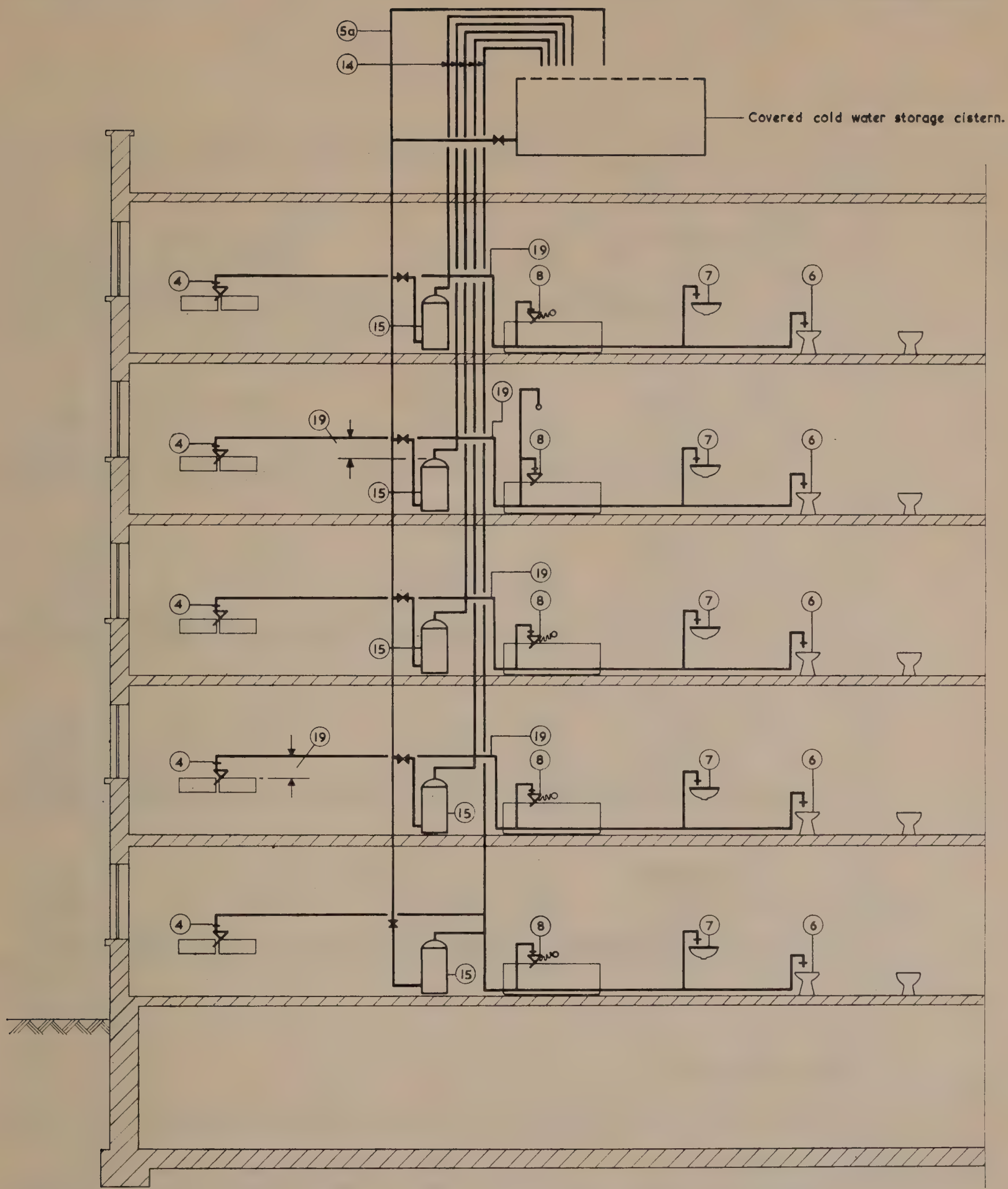
12 Water softener — Built in Class 3 protection

i Part of stored system

5a Vent pipe

5b Upstands

Hot water service



ii Additional protection of stored system

1 WC pan (Class 1 risk Flushing cistern (Class 2 protection on inlet on inlet)

6 Bidet over-rim type (Class 1 risk)

7 Wash basin — With or without mixer taps or mixer valves fixed or flexible shower units, no additional protection necessary with 5a and 5b but Class A air gaps preferred at taps

8 Baths

Notes relative to hot water supply only

14 Vent pipe (one from each calorifier)

15 Calorifier/immersion heater

19 Upstands

Not illustrated

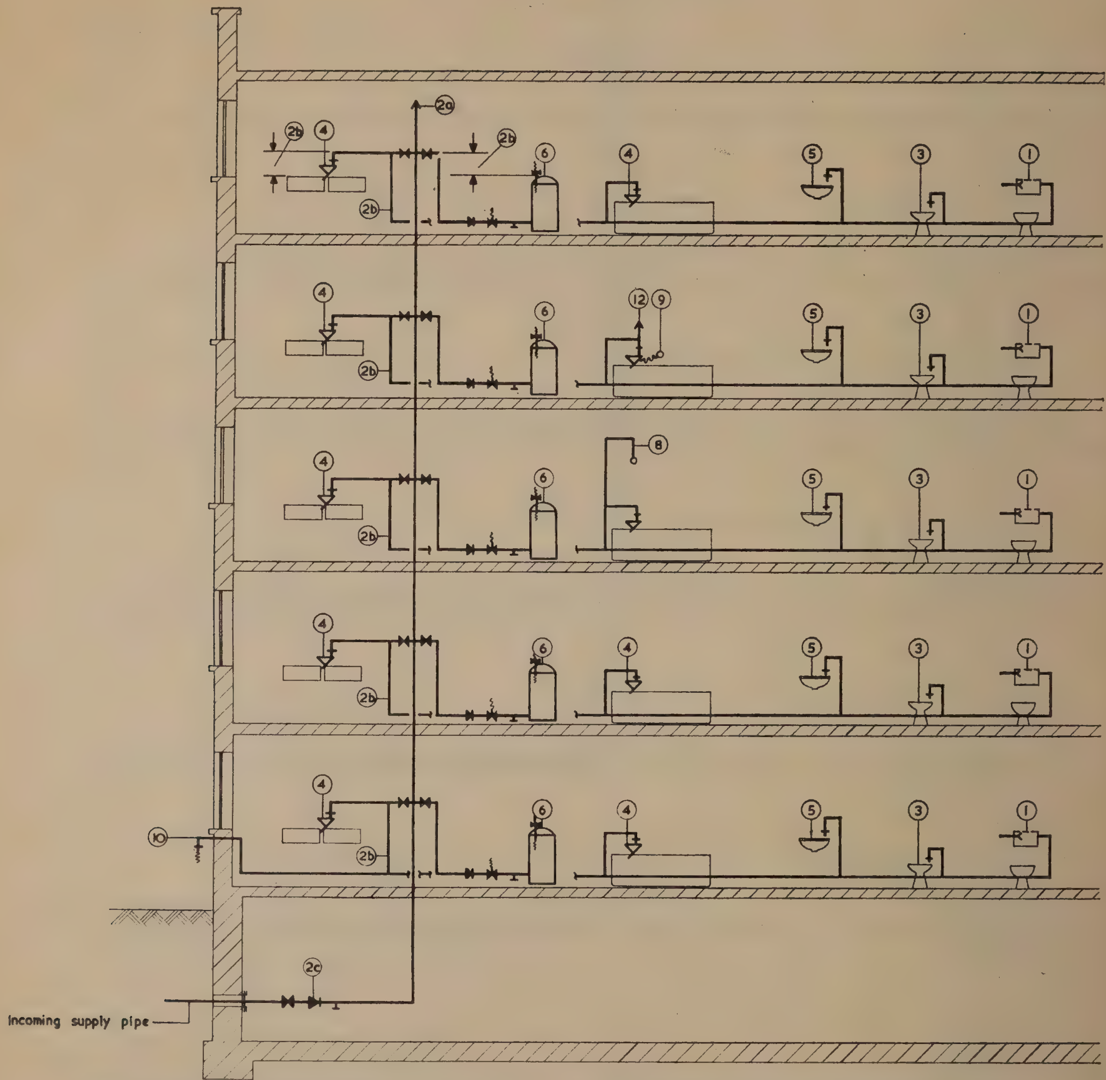
Central heating system principles on the large residence drawing would apply – namely separate feed cistern with Class 2 protection and vent pipe

Multi-storey block of flats

Fully pressurised hot and cold water supplies

Drawing D

Cold water services



Notes relative to hot and cold supply

(Whole installation protected)

1 WC pan (Class 1 risk) Flushing cistern (Class 2 protection on inlet)

2a Terminal anti-vacuum valve (part of whole installation protection)

2b Upstands (take off appropriate distance above associated highest water levels at connected appliances)

3 Bidet (Class 1 risk) over-rim type

4 Single outlet type – combination tap assembly

5 Wash basin – outlet taps set at Type A air gap (preferably)

6 Immersion type hot water supply cylinder

8 Fixed shower fittings protected in flats by 2a and 2b

9 Flexible hose shower attachment (Class 2 risk) protected in flats by 2a and 2b

10 Garden/garage hose tap connection (Class 2 risk)

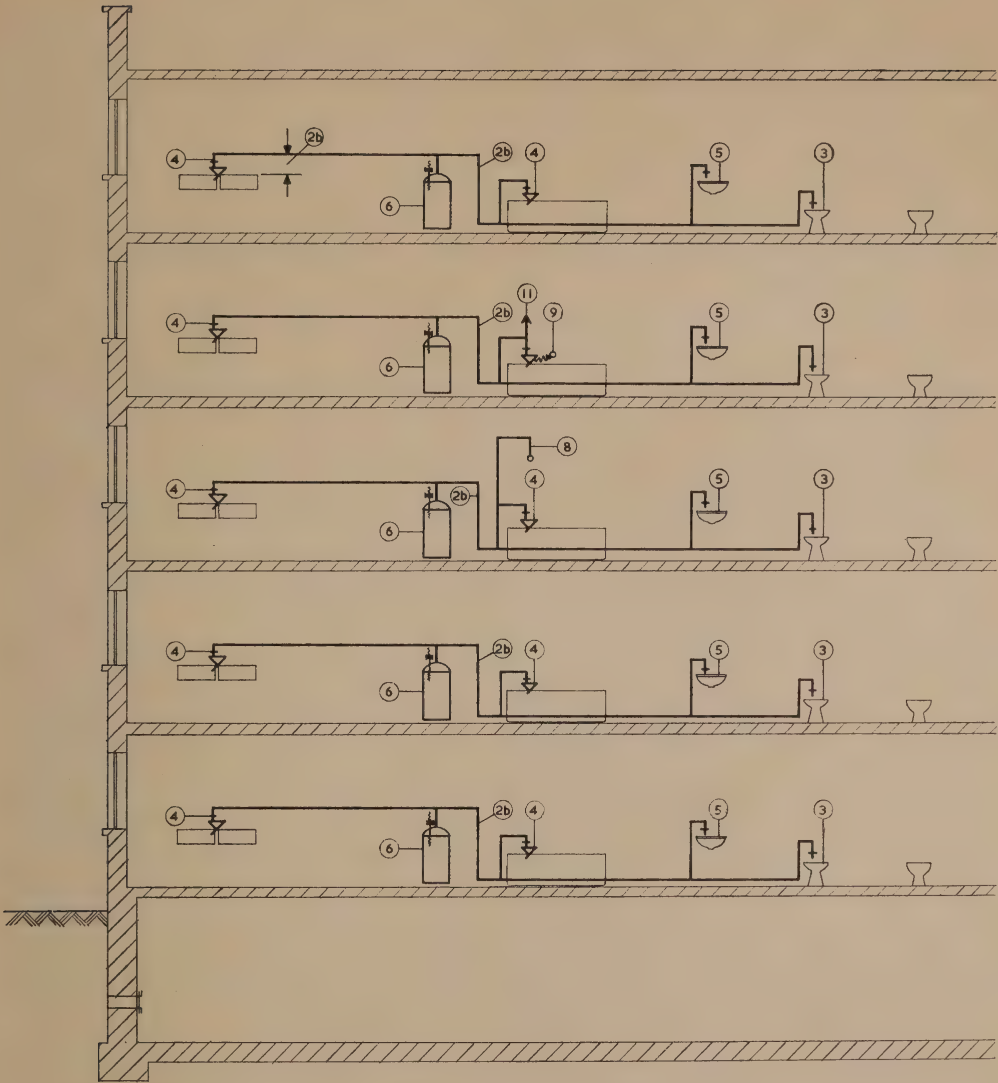
11, 12 Anti-vacuum valves associated with item 9

2c Check valve (part of whole installation protection)

N.B.

Satisfactory service can be assured only where water pressures are constantly available at levels above the highest connected fittings

Hot water services



Other titles on Water Supply and Pollution

Other titles on Water Supply and Pollution

Out of Sight Out of Mind: Report of a Working Party on Sludge Disposal in Liverpool Bay

Volume 1	Main Report	**£1** (£1.06)
Volume 2	Appendices	**£7** (£7.32)
Volume 3	Report for 1972–73	**£2** (£2.12)

Water Resources in England and Wales 1973

Volume 1	Report	**£3.50** (£3.65)
Volume 2	Appendices	**£4.20** (£4.37)

Background to Water Reorganisation in England and Wales **53p** (63p)

River Pollution Survey of England and Wales (Updated 1972):
Discharge of Sewage and Industrial Effluents, 1973 **50p** (60p)
River Quality **30p** (36p)

Water Services: Estimates and Accounts **73p** (83p)

Water Services: Economic and Financial Policies.
First report to the Secretary of State for the Environment **47p** (52p)

Prices in brackets include postage

Further titles on this subject are listed in Sectional List No 5 (Department of the Environment List A) and can be obtained from Her Majesty's Stationery Office, PM1C, Room C46, Atlantic House, Holborn Viaduct, London EC1P 1BN

Government publications can be bought from the Government Bookshops in London (post orders to PO Box 569, SE1 9NH) Edinburgh, Cardiff, Belfast, Manchester, Birmingham and Bristol, or through booksellers. See Yellow Pages for your nearest stockist of Government publications.

HMSO BOOKS

HER MAJESTY'S STATIONERY OFFICE

Government Bookshops

49 High Holborn, London WC1V 6HB
13a Castle Street, Edinburgh EH2 3AR
41 The Hayes, Cardiff CF1 1JW
Brazennose Street, Manchester M60 8AS
Southey House, Wine Street, Bristol BS1 2BQ
258 Broad Street, Birmingham B1 2HE
80 Chichester Street, Belfast BT1 4JY

Government publications are also available through booksellers

£1·75 net

ISBN 0 11 750845 4